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CONTENTS

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IN THIS ISSUE

In a paper "Problems of Trend Determination During a Transition in Fertility," N. B. Ryder emphasizes the need for using various measures of fertility if one is to secure well-balanced interpretations of past trends and the best possible judgments regarding the future. By way of illustration he uses the vital statistics for Sweden for the century and a half since 1801. Although the official data are of limited type the author exhibits much ingenuity in devising ways and means of bringing out various aspects of fertility trends such as the contrasts between period fertility and cohort fertility, between current fertility and total fertility, and between fluctuations and secular trends.

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Those who are concerned with problems of economic development of areas of high population pressure sometimes search almost anxiously for signs of emerging differentials in fertility. Since declines in fertility are said to begin among urban groups of high socio-economic status, the emergence of class differences in fertility is sometimes interpreted as the harbinger of declines in fertility. In this issue Dr. M. A. El-Badry presents a paper "Some Aspects of Fertility in Egypt" in which he is concerned mainly with the search for evidences of variations in size of family by rural-urban and socio-economic status. According to his conclusion, "No evidence was found in the census or vital statistics data to support the assumption of lower fertility in urban than in rural Egypt. Reproduction was found to be lower to some extent among a limited number of educated people in urban areas."

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Lois Pratt and P. K. Whelpton contribute an article "Extra-Familial Participation of Wives in Relation to Interest In and Liking for Children, Fertility Planning, and Actual and Desired Family Size." The analysis is based upon data collected in the Indianapolis Study and it relates to the experience of 1,309 "relatively fecund" couples with children in the adjusted sample of that Study. This is the thirtieth of a series of articles being published in the *Quarterly* under the general title "Social and Psychological Factors Affecting Fertility."

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In recent demographic literature there have been several articles purporting to indicate that declines in fertility have been much more important than declines in mortality in bringing changes in the percentage age distribution of the population. None of these, however, has provided the generic mathematical demonstration that is afforded in an article in this issue by Ansley J. Coale "The Effects of Changes in Mortality and Fertility on Age Composition." On the basis of his data, Coale concludes: "A rise in fertility produces an increase in the proportion in the younger age groups at the expense of the older; a proportionate increase at all ages in the probability of surviving affects only the growth rate; an extra increase in survivorship at the youngest ages has an effect much like a rise in fertility; an extra increase in survivorship at the older ages tends to raise the fraction at these ages."

PROBLEMS OF TREND DETERMINATION DURING A TRANSITION IN FERTILITY

N. B. Ryder[1]

A CONTROVERSIAL component of recent population literature is the theory of the demographic transition, or, as it is sometimes called, the vital revolution. This loosely-woven set of propositions about the nature, causes, and consequences of long run decline in mortality and fertility, which received its major impetus from the work of the Princeton school of demographers[2] was acclaimed by Rupert Vance, in his presidential address to the Population Association of America, in 1952,[3] as the best opportunity for theory in a profession rife with empiricism. In contrast with this hope are the assertions of demographers working on underdeveloped areas that the transition theory is special to the West.[4] Even this limitation on generality is not stringent enough to suit some, and in particular Joseph S. Davis, who asserts that the United States and the British Dominions require a theory of their own, on the presumption that their fertility is not now declining.[5]

One contribution that a methodologist may make to the construction or demolition of the transition theory is in a sense a semantic one: to establish operational definitions of the vocabulary being used and determine relationships between component parts of the structure of ideas, so that the protagonist and antagonist may at least converse with each other. The present paper is intended to discuss some matters pertinent to the central concept in the vital revolution—the trend of fertil-

[1] Scripps Foundation for Research in Population Problems, Miami University.

[2] *See,* for example, Notestein, F. W.: Population—The Long View, pp. 36–57 in Schultz, Theodore W. (ed.), Food for the World, University of Chicago Press, 1945.

[3] Vance, R. B.: Is Theory For Demographers? *Social Forces,* 31, 1, October, 1952, pp. 9–13.

[4] *See,* for example, the papers by Irene B. Taeuber and Kingsley Davis in The Interrelations of Demographic, Economic, and Social Problems in Selected Underdeveloped Areas, New York, Milbank Memorial Fund, 1954, pp. 9–31 and 66–89.

[5] Davis, J. S.: Population and Resources. *Journal of the American Statistical Association* 45, 251, September, 1950, pp. 346–349.

ity. There are many definitions of fertility, depending on the nature of the hypothesis being examined or, more frequently, the type of data available. Some of these are discussed here in terms of setting forth relationships between the time series of the different measures and thus indicating the extent to which a proposition about changing patterns of childbearing, with one type of measure in mind, needs to be amended if another definition is utilized. The establishment of a bridge between various definitions of fertility has been a major achievement of recent demography. This paper may be viewed as an attempt to apply some aspects of this achievement to an important segment of demographic theorizing. That fertility declined in the West during the past century is a fact on any measurement basis. But it now seems desirable to attempt to introduce a greater level of precision into the observations, to measure the changing rate of decline, the length of the interval between falling mortality and falling fertility—in short to move from a verbal to a quantitative level of statement.

The measure most frequently encountered in publications dealing with the vital revolution (aside from the generic term 'fertility') is the birth rate.[6] The frequency of occurrence of this term is almost certainly not evidence of a choice on analytic grounds but rather a reflection of the plain fact that, for most countries during the early phases of the small-family movement, this is the only measure which can be calculated. Furthermore the term "birth rate" is apparently used as a general synonym for fertility in writings for a non-technical audience. It should, however, be added in defense of this much-maligned measure that it is an unequivocal measure of the consequences of the various forces which it is the purpose of refinement to unravel.

A second meaning of fertility is that given by some index of the age-specific birth rates observed during a particular period.

[6] For example, Vance's chart of the course of the vital revolution in England portrays changes in the crude birth and death rates. Vance, R. B.: The Demographic Gap. Pp. 9–17 in Approaches to Problems of High Fertility in Agrarian Societies. New York, Milbank Memorial Fund, 1952.

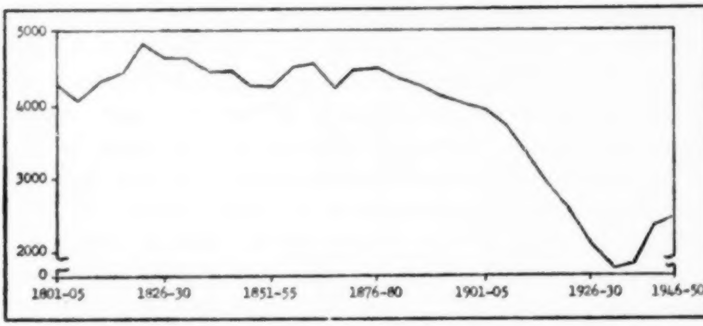


Fig. 1. Crude birth rate (per thousand), Sweden, 1801–1950.

Although the most common of these indices is the gross reproduction rate, it has seemed preferable here to use the total fertility rate, which is virtually the same except that it summarizes age-specific rates for all births rather than just for female births. This preference is based on a desire to avoid the implication of replacement or of connection with the stable population model (which, because it is a static model, is peculiarly inappropriate to the study of demographic change.) In Figures 1 and 2, the Swedish crude birth rate and total fertility rate are plotted for five-year periods during 1801–1950. Where these measures are distinguished, in articles discussing long run move-

Fig. 2. Period total fertility rate (per thousand), Sweden, 1801–1950. [See Appendix B.]

ments in reproductivity, the implication is that the crude rate is inferior to the other as a measure of fundamental fertility, because of the influence of a changing age distribution.[7] The thesis, a classic one in demographic discussion, is that, under a regime of declining mortality followed by declining fertility, the age distribution evolves in such a way as to inflate temporarily the age groups responsible for childbearing. This was perhaps the most striking feature of the famous 1925 article by Dublin and Lotka.[8] The picture conveyed in such discussions of the subject is of a transitory phase in the vital revolution in which the crude birth rate is hoisted to spurious heights because of a wave of growth passing upward through the age structure, much like a boa constrictor swallowing a pig. Such contamination of the trend is eradicated by performing the operation of age-specification and achieving a total fertility rate.

In the writer's opinion the influence of the long run evolution of the age distribution, during the course of a typical demographic transition, on the trend of fertility as depicted in a time series of crude birth rates would seem to be fairly modest. Figure 3 contains a graph of the relationship between movements of the crude birth rate and movements of the total fertility rate in Sweden.[9] It is evident from this graph that significant distortions of fertility behavior can occur if reliance is placed on the crude birth rate as a measure, but in the present instance at least they are attributable in the main to transitory factors. The early trough and peak in Figure 3 was caused by a sharp

[7] For instance, in Notestein, F. W.: The Population of the World in the Year 2000. *Journal of the American Statistical Association* 45, 251, September, 1950, pp. 335–349.

[8] Dublin, L. I., and Lotka, A. J.: On the True Rate of Natural Increase. *Journal of the American Statistical Association*, 20, 151, September, 1925, pp. 305–339.

[9] Since the crude birth rate and the total fertility rate are measures with different dimensions, it was considered advisable in comparing their time series to express each series in terms proportional to the mean value for the whole series and then to divide the consequent relative crude birth rate by the consequent relative total fertility rate for each time period. This practice seems justifiable because of the high degree of similarity of the curves as shown in Figures 1 and 2. The coefficient of variation of the crude birth rate series is 22.6 per cent and of the total fertility rate series is 23.9 per cent.

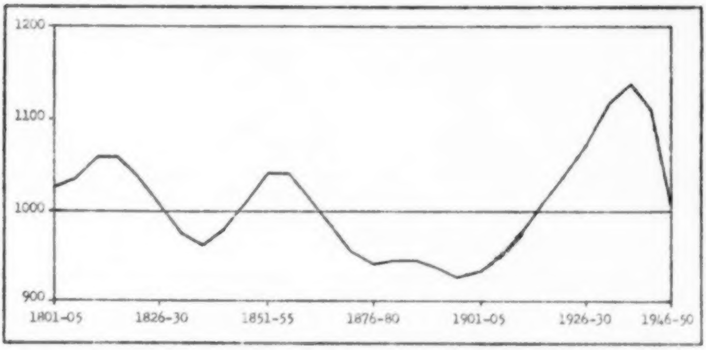


Fig. 3. Ratio of relative crude birth rate to relative total fertility rate (per thousand), Sweden, 1801–1950. (See footnote 9 in the text.)

drop in mortality, particularly among children, which released a wave of growth depressing the crude birth rate until the larger cohorts advanced into their reproductive prime of life. The second and more extended trough was a function of the very heavy migration of the late nineteenth century, which was highly selective of young women. Even more telling in its effect on the relationship between the crude birth rate and the total fertility rate is a fluctuation in fertility, because its influence is focused on one age alone, viz., zero. Thus the great depression is reflected in the recent sharp peak in Figure 3. In addition to these familiar factors, there is another which, although modest in its empirical significance, has been unjustly ignored in the literature. The section of the age distribution which affects the birth rate directly is that which lies within the reproductive age span. Now the relative importance for childbearing of various age groups may and does change considerably, as will be noted presently. A significant component of the transformation of reproductive patterns in the West has been a shift of the locus of fertility toward a lower and lower age. Since the younger age groups are typically larger than the older, this shift induces a less rapid rate of decline in the crude birth rate than in the total fertility rate.[10]

[10] For a statement of this in symbolic form, *see* Appendix A.

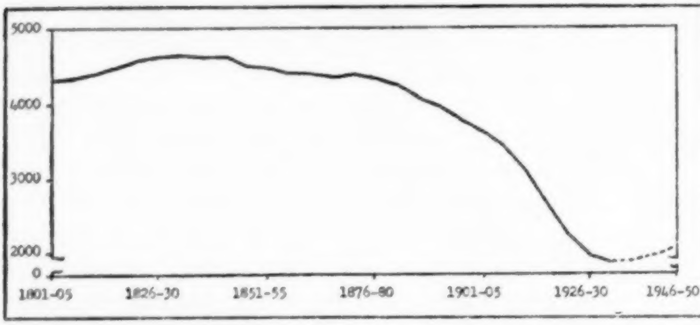


Fig. 4. Dated cohort fertility rate (per thousand), Sweden, 1801–1950. [For sources and dating procedure, see Appendix B.]

The total fertility rate discussed up to this point is computed by summing the age-specific birth rates of the female population during a given time period. If a table of such rates is prepared for a population through time, with the rows representing ages and the columns time periods, then the sum of any column is the total fertility rate for the period concerned. The convincing claim has been put forward in numerous recent publications [11] that it is more meaningful for most analytical purposes to consider not the synthetic aggregate of the behavior of women of different ages in a single period, but rather the complete history of childbearing of women born at the same time, birth records being cumulated throughout their lives, and age increasing *pari passu* with time. This latter concept would be represented in the aforementioned table by the sum of a diagonal of birth rates, called the cohort total fertility rate. Thus there are two time series of total fertility rates available, one cohort and one period. The latter has been presented in Figure 2 above; the former is shown in Figure 4. The two series are approximately alike, except for the greater short run variability of the period than of the cohort series. Similarities are, of course, to be expected, since both series summarize the same table of fertility as a function of age and time, but there are

[11] For a bibliography and discussion, *see* Stolnitz, G. J. and Ryder, N. B.: Recent Discussion of the Net Reproduction Rate. *Population Index* 15, 2, April, 1949, pp. 114–128.

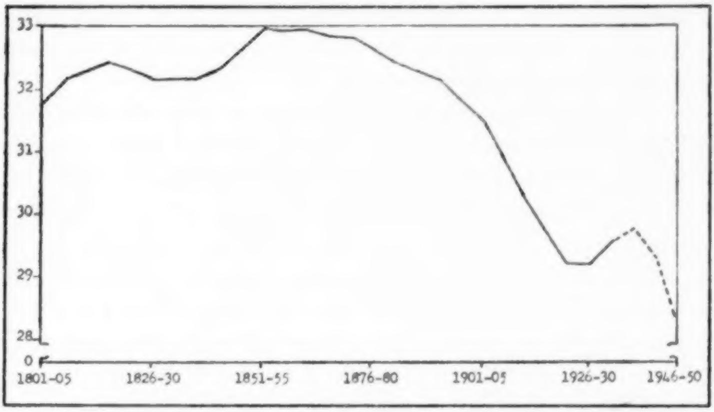


Fig. 5. Dated cohort mean age of fertility, Sweden, 1801–1950. [For sources and dating procedure, see Appendix B.]

points of critical difference at the refined level of statement required for progress in knowledge of the vital revolution. (*Vide infra.*)

It is now well-recognized that period indices of age-specific fertility are highly responsive to year-to-year changes in the socio-economic climate, without any necessary inference that such movements reflect changes in the total childbearing of the constituent cohorts in the population. It is also generally agreed that the mechanism of this fluctuation, the proximate source in an arithmetical sense, is the variations which occur in the timing of childbearing, either because of marriage postponement, or because of postponement of births within marriage.[12] It is not appreciated however that changes in the timing of childbearing create a divergence of the trend of period fertility from that for cohorts not merely when the changes are temporary and violent, such as in a context of war or depression, but also when they have a gradual long run character. In Figure 5 a simple measure of the timing of fertility is plotted. This measure is computed for a cohort by multiplying each age by

[12] *See* Whelpton, Pascal K.: Cohort Fertility, Princeton University Press, 1954, Chapter 6 *et passim.*

its respective fertility rate, summing the products and dividing the sum by the total fertility rate. In other words it is the mean of the fertility-age function.

As seen in the graph, major changes in this measure have accompanied the transition of fertility from a high to a low level. Since the middle of the nineteenth century the mean age of fertility has followed a strong downward course in Sweden, mostly because the birth rate has fallen more sharply in the older than in the younger childbearing ages, but partly because the mean age at marriage has been declining. Now when successive cohorts bear children in approximately the same time pattern, their fertilities overlap, so to speak, so that the amount of fertility in any one period corresponds with the average amount of fertility for the constituent cohorts. But if the mean age of fertility is falling, the births of successive cohorts are bunched more closely together—there is an augmentation of the normal overlap—and the fertility of any one period tends to exceed that of the cohorts represented therein. The period receives a spurious surplus of births. An example of the converse proposition is a postponement situation, such as occurs during a depression. Postponement may be rephrased as a rise in the average age at which childbearing occurs—a diminution of 'normal' overlap—leading to a spurious deficit of births in the period concerned.[13]

To permit closer inspection of the ways in which the time series of period fertility differs from that for cohort fertility the ratio of the period total fertility rate to the cohort total fertility rate has been calculated and the results are presented in Figure 6, labelled the "Index of Timing Distortion." It is clear from this graph that, contrary to what might be the superficial

[13] These matters have been discussed at length in the writer's unpublished Ph.D. dissertation, "The Cohort Approach. Essays in the Measurement of Temporal Variations in Demographic Behavior," Chapter IV, Princeton, 1951. A parallel and independent treatment dealing principally with nuptiality and emphasizing short run variations in timing is contained in Hajnal, John: Births, Marriages and Reproductivity, England and Wales, 1938–47, Section D, pp. 385–403. REPORTS AND SELECTED PAPERS OF THE STATISTICS COMMITTEE, PAPERS OF THE ROYAL COMMISSION ON POPULATION, VOLUME II. London, His Majesty's Stationery Office, 1950.

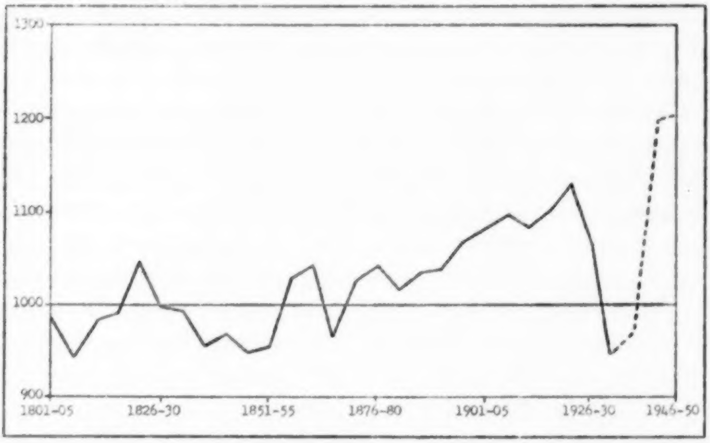
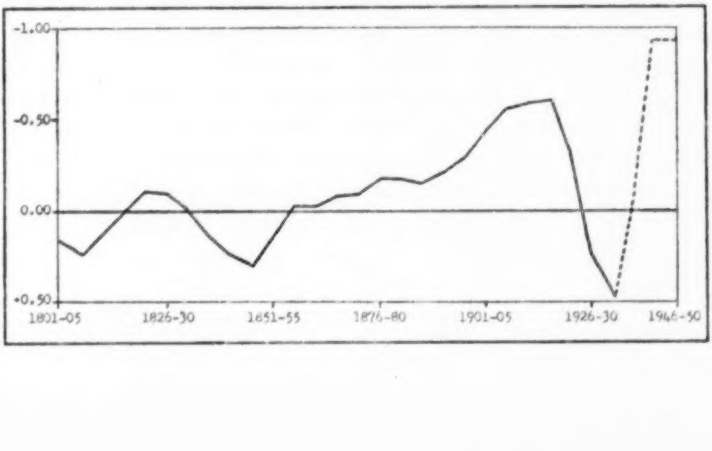


Fig. 6. Index of timing distortion (per thousand), Sweden, 1801–1950. Ratio of period total fertility rate (Fig. 2) to dated cohort total fertility rate (Fig. 4).

impression concerning the relationship of these two measures, the period rate does not merely fluctuate about the cohort rate. On the contrary it has shown systematic long run divergence from the cohort series—and at times of considerable proportions. Over a sixty-year span, period fertility in Sweden was higher than that for cohorts, and the discrepancy mounted to 13 per cent. The great depression reversed the direction of

Fig. 7. Change in cohort mean age of fertility (plotted inversely), Sweden, 1801–1950. [For dating procedure, see Appendix B.]



distortion temporarily, but during the 1940's period-type fertility was apparently about twenty per cent higher than its cohort counterpart.

Changes in the timing of fertility of successive cohorts have been responsible for the divergence of the period fertility series from that for cohorts. In Figure 7 are plotted (inversely) the changes in the mean age of fertility from cohort to cohort. The high degree of correspondence between changes in fertility timing, shown in this graph, and the distortion of cohort fertility by the period rate, shown in Figure 6, is immediately evident. On the basis of the above, it is considered important in any attempt to refine propositions concerning the vital revolution to pay careful attention to possible changes in the timing of cohort fertility, because of the direct way in which these changes, whether they are short run or long run, cause the various period-type measures of reproductive performance to distort underlying cohort behavior. As a specific corollary to this proposition, it seems likely that postwar fertility in the Western world has been spuriously high not only because of the recovery of postponed births, but also because of the gradual but persistent trend toward earlier childbearing. This defect of period-type measures is, furthermore, not removed by increasing the level of specificity of the rates, i.e., by computing birth rates which are specific for parity, for marital duration and so forth. So long as these indices consist of the aggregation of birth rates for a series of cohorts in a particular period, they bear the mark of any changes which may be occurring in the time pattern of fertility.[14]

There is, of course, plenty of scope for the refinement of measures of cohort behavior beyond the level of age-specificity. Probably the most common fertility referent in the analysis of reasons for decline is the concept of family size. This measure of fertility may be defined operationally as the ratio of the number of legitimate births to a cohort of women, divided by the

[14] *See* Ryder, N. B.: The Comparative Relevance of Cohort Aggregation and of Increased Specificity in the Determination of the Trend in Fertility. World Population Conference, Rome, Italy, September, 1954.

number of first marriages occurring prior to menopause. Alternatively the computation may be based on census records of children born to ever-married women who are now beyond the fecund ages. Either of these measures of cohort family size (which differ only to the extent that mortality or migration may be selective in respects relevant to childbearing) will in general yield a different time series, a different trend of fertility, from that depicted in a graph of cohort total fertility rates, and the divergence requires explicit consideration if the hypotheses being examined bear on the character of familial institutions. The reason for discrepancy in this case is, simply, the variations of nuptiality as a function of time. That marriage is a more dynamic variable than was thought previously has been amply documented in Hajnal's recent group of articles on the subject.[15] The materials assembled by the present writer in this connection have been presented elsewhere in an article which is, in a sense, a companion piece to the present one.[16]

The list of different fertility measures, each of relevance to some phase of the analysis of declining reproductivity, could easily be extended.[17] For present purposes it may suffice to note that the special characteristics of each measure tend to give it a unique time-pattern of change, which cannot necessarily be inferred from the time series of some other measure. Another problem, implicit in the above discussion, deserves however a short comment. It is clear that the theory of the demographic transition is couched in terms of a long run model and that the statements about changing patterns of childbearing refer to the trend in fertility rather than to whatever fluc-

[15] Hajnal, J.: Age at Marriage and Proportions Marrying. *Population Studies*, 7, 2, November, 1953, pp. 111–136, (among others).

[16] Ryder, N. B.: The Influence of Declining Mortality on Swedish Reproductivity. Current Research in Human Fertility, Proceedings of the 1954 Annual Conference of the Milbank Memorial Fund. Milbank Memorial Fund, 1955, pp. 65–81.

[17] For example, probably the most pertinent measure for testing the influence on fertility of the increasing use and efficacy of contraception is the ratio of conceptions to exposed fecund ovulations. This ratio can vary through time quite differently from the fertility rates discussed above because failure to prevent conception confers a period of immunity, i.e., of pregnancy, whereas success in preventing conception implies exposure to the risk of conception at the time of the next ovulation.

tuations may be occurring. The test of the hypothesis of declining fertility in the United States, for example, requires prior agreement on the manner of identification of the trend, as well as on exactly which "fertility" is being examined. Although a large part of the apparent transitory variability in reproductive performance vanishes when cohort measures are utilized in preference to the conventional period indices, numerous problems remain unanswered in this area unless there is an arbitrary decision to define the trend as whatever successive cohorts do. For example, the tables of age-specific order-specific birth rates for native white female cohorts in the United States, assembled by Whelpton,[18] can be used to show that more births per woman will occur in some later cohorts than in some earlier ones in recent American history. Before this is signalled as a reversal of secular decline, there must be an assessment of the extent to which the cohorts which spent their most important reproductive years enduring the ravages of the depression incurred because of this a loss which could not be later recovered. In the second place, a part of the rise in cohort fertility which is occurring is attributable to an increase in the number of families, i.e., in the likelihood of marriage, as distinct from the number of children per family (which is the focus of study in the theory of declining fertility). Finally the rise which is occurring is for the most part a matter of decreases in the proportions of families with no child or one child, decreases which more than counterbalanced the continuing decline in families with larger numbers of children. The average family size for women with at least two children is clearly continuing its downward path. For example, the cohort of women born in 1906, which by January 1, 1953 had effectively completed its childbearing, spent many of its good reproductive years enduring the depression and arrived in the postwar period at too late an age to do much toward recouping its deficits. Nevertheless the women of this cohort in parities two and higher had at every age a higher average number of births than

[18] *Op. cit.*, Table A.

any of the following cohorts have achieved (at a comparable age) up to 1953.[19]

In short, the adoption of the cohort viewpoint is a necessary but not a sufficient condition for adequate interpretation of current fertility movements. Furthermore the user of cohort tables requires an excessive amount of discretion (not to mention patience) because if he were to compare the levels of fertility achieved by two cohorts whose experience was still incomplete, he would be in danger of recording quantity differentials which might be entirely attributable to the phenomenon on which attention has been focused above, viz., modifications in the timing of childbearing. The failures of the forecasters may in large part be attributed to the confusion of long run quantity variations with short run timing variations, partly because of a lack of distinction between period fertility and cohort fertility, and partly also because of the impatience which is a chronic feature of a policy-oriented science. At the same time, the critics of these forecasts[20] are open to the charge that they too have failed to distinguish between trend and fluctuation—and the meaning given to "fertility" is often restricted to the crude birth rate, if not the number of births. The forecasters looked at the 1920's and 1930's and saw major decline; the critics looked at the 1930's and 1940's and saw major expansion. The controversy has been somewhat reminiscent of the story about the blind men interpreting the elephant from different ends.

The need to be crystal-clear about what is being measured is more important now than ever before. Figure 8 contains the graph of the conventional gross reproduction rate for the United States, 1930–54. This measure of "intrinsic" fertility has been increasing now for twenty years. The only irregularities in this

[19] This calculation is made by computing the ratio of the cumulative birth rates of orders two, three, and higher to the cumulative birth rate of order two, as published in Tables A and G of Whelpton, *op. cit.*, and in the mimeographed supplement to Table G (Scripps Foundation, March, 1955), for the cohort of 1906 and for the experience of the various younger cohorts up to January 1, 1953.

[20] Especially Davis, Joseph S.: The Population Upsurge in the United States. Food Research Institute, Stanford, 1949.

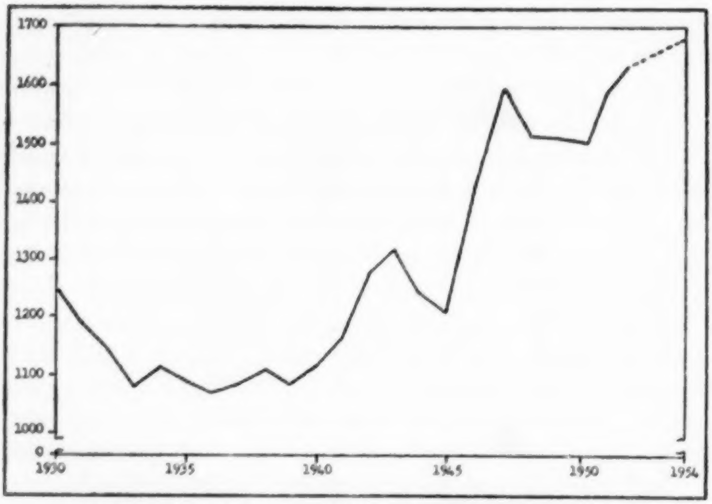


Fig. 8. Gross reproduction rate, United States, 1930–54. (Sources: 1930–39, United Nations, DEMOGRAPHIC YEARBOOK, 1954, page 456; 1940–52, United States, National Office of Vital Statistics, *Vital Statistics-Special Reports* 40(10), March 4, 1955; 1953–54, estimated by the writer on the basis of official preliminary birth reports.)

upward trend occur in connection with peaks following the depression and following the war. The behavior of the 1950's is presumably relatively unaffected by the occurrence of postponed births. If this time series were taken at face value, the bulk of fertility theory would have to be re-written. The purpose of the present paper has been to suggest a few methodological precautions which may make such a revision unnecessary.

APPENDIX A

The relationship between the period crude birth rate and the period total fertility rate may be expressed in the following way:

Births to women aged a during the period concerned = B(a);

Number of women aged a in the mean population for the period = N′(a);

Mean population for the period (both sexes) = N;

$$\text{Crude birth rate} = b = \frac{\Sigma B(a)}{N}$$

$$\text{Total fertility rate} = F = \Sigma\left[\frac{B(a)}{N'(a)}\right]$$

Then $b/F = \Sigma[d(a) \cdot p(a)]$,

$$\text{Where } d(a) = 1/F\left[\frac{B(a)}{N'(a)}\right]$$

$$\text{and } p(a) = \left[\frac{N'(a)}{N}\right]$$

All summations are for the range of the childbearing ages.

Thus the relationship between the crude birth rate (b) and the total fertility rate (F) may be expressed as a weighted sum of the proportions of the total fertility rate contributed by each of the childbearing ages $[d(a)]$, the weights being the proportions of the total population which are in those particular ages (and are female) $[p(a)]$. Since the customary shape of the age structure implies larger proportions of the population at younger ages, i.e., $p(a)$ varying inversely with a, a tendency for the fertility of younger females to be enhanced relative to that for older females, i.e., for $d(a)$ to become somewhat larger for the lower ages and somewhat smaller for the higher ages, will lead to a rise in b/F. Speaking empirically, the decline in the mean age of fertility in Sweden in the past century has had the effect of reducing the rate of decline of the crude birth rate relative to that of the total fertility rate.

Appendix B

The period total fertility rates (Figure 2), the cohort total fertility rates (Figure 4) and the cohort mean ages of fertility (Figure 5) are based on female age-specific confinement rates for five-year age groups for five-year time periods, Sweden, 1751–1950. For the period 1751–1900 the source of these rates is Bevölkerungsstatistik Schwedens (Gustav Sundbärg, Stockholm, Norstedt, 1907). For the period 1901–1950 these rates have been gathered by the writer from the official yearbooks (Statistisk Årsbok) and publications of vital statistics (Beføklningsrörelsen) for the individual years. For the most recent cohorts plotted in the graphs, fertility rates at the older ages have been estimated by simple extrapolation procedures.

The calculations performed may be symbolized as follows: Fertility rate women of age i in time period $j = f_{i,j}$. Total fertility rate for period $j = \Sigma f_{i,j}$.

Total fertility rate for the cohort born in period $j = \Sigma f_{i,j+i}$.

Mean age of fertility for the cohort born in period $j = \left[\frac{\Sigma i \cdot f_{i,j+i}}{\Sigma f_{i,j+i}}\right] = \bar{i}_j$.

All summations are for the range of the childbearing ages. These equations are expressed in single-year form for the sake of convenience; for five-year age and time divisions the computation principle is exactly the same.

In the figures in the text, the cohort values for the various parameters have been plotted in alignment with the particular periods for which period parameters are available. Now the time span of childbearing of the cohort born in year j runs from the time corresponding to the cohort's earliest age of childbearing (say $j+15$) to the time corresponding to its latest age of childbearing (say $j+49$). For the purpose of comparison of cohort values with period values, it was decided arbitrarily (but not unreasonably) to date the particular cohort parameter at the time point corresponding to its mean age of fertility, in other words at the middle of its childbearing period by one definition. Thus the cohort born in year j was considered to have its fertility parameters located at time point $j+\bar{i}_j$. Values of each parameter were obtained for the times corresponding to the midpoints of the periods identified in the various graphs by linear interpolation between the values for the cohorts with dates bordering on either side of the required date. The only exception to this procedure is the graph of changes in the cohort mean age of fertility (Figure 7), for which a separate interpolation of values of the cohort mean age of fertility was undertaken for dates half-way between those plotted in the other graphs, so that the differences in successive cohort mean ages of fertility would be appropriately aligned in a temporal sense.

The relationship between the ordinate scales of Figures 6 and 7 is not arbitrary. By means of simple mathematical models it may be shown that a decline of the mean age of fertility by x years between two cohorts which are t years apart tends to give a period total fertility rate a value which is $(1+x/t)$ times the corresponding cohort total fertility rate. In the above empirical presentation, $t = 5$, so that a decline of, say, 0.5 years in the mean age of fertility between two successive cohorts tends to yield an index of timing distortion of 1000

$(1 + 0.5/5) = 1100$. In practice the indicated relationship is only approximately valid, primarily because the mean of the fertility-age distribution is inadequate to represent the complicated changes in the distribution of fertility through time which may actually be occurring from cohort to cohort.

SOME ASPECTS OF FERTILITY IN EGYPT

M. A. El-Badry[1]

Introduction

The growing concern in Egypt about the rapid increase of its population makes desirable more accurate knowledge of the reproductive experience among the various sections of the population.

The available data do not allow a definitive study of attitudes, nor do they permit the investigation of the extent to which methods of birth limitation are known and deliberately practiced within any of the social classes. It is possible, however, to utilize the available data to discuss several important questions such as whether there exist any fertility differentials between urban and rural populations, which sections of the population are less reproductive than others, and what the reproduction of a married woman would be at the termination of her reproductive period in marriage. These are the points which will be considered in this paper.

Available Data

A study which aims at discovering satisfactory evidence as to whether there exist any fertility differentials between social classes must be based on comparison between homogenous groups in these classes. The investigator should therefore have access to data on the age, duration of current or last marriage, and number of children born to every woman currently married, widowed, or divorced. It is also helpful to know the history of marital life of women who have been married more than once. This latter information is more difficult to obtain and studies are often restricted to the current marriage.

The census of 1947 was the first to include data on reproduction by age of mother and duration of marriage. The published results of this census include three tables which distribute the

[1] Office of Population Research, Princeton University.

married women in the whole country at the time of the census according to: (1) number of children ever born during the current marriage, by duration of this marriage; (2) number of children ever born during the current marriage, by age of the woman at the census; and (3) duration of current marriage and age at the census.

Each of these tables includes two of the three variates: number of children, duration of marriage, and age. A table which includes the three variates would have been much more useful. It would have divided the population of married females into much more homogeneous groups and also given a clearer picture of the reproductive history of the female. Such data are unfortunately not available, although the relevant information is necessarily on the punch cards.

The usefulness of the above tables is greatly reduced by the fact that they relate only to the whole country. Their value to a study of differential fertility would have been greatly enhanced had the tabulations been made according to broad employment brackets or geographic regions.

All we can get from the census about fertility by regions are three univariate tables for each region; one giving the number of children ever born during the current marriage for each married woman, another giving the age distribution of married women, and a third giving a distribution of the same women according to duration of their current marriage. Cross-classifications of these variables are not available in the published census results.

In addition to the above census materials we have several useful vital statistics tables. We will employ here a 1947 vital statistics table which distributes the fathers of babies born in Health Bureau areas in 1947 according to order of the birth and occupation of the father. Several other statistics about marriage and divorce in 1947 published in the same volume will also be utilized.

Three partial adjustments in the census tables have been made for present purposes. The first relates to the reported

Duration of Marriage in Years	Percentage of Women With "Number of Children Not Given"
0–4	22.06
5–9	7.62
10–14	4.92
15–19	4.25
20–24	4.16
25–29	3.75
30–34	4.22
35–39	3.83
40–44	4.30
45 and Over	4.68
Not Given	55.96

Table 1. Percentages of women classified in the 1947 Census of Egypt as "number of children not given," by duration of marriage.

frequency of childless married women of marriage duration 0–4 and 5–9 years. The reason for this adjustment can be seen from the percentages of women classified under "number of children not given" in each marriage duration in Table 1. The reader will notice outstanding proportions of women for whom the number of children was not given on the census sheet in the first two duration intervals. The excess in the first two percentages is in all probability attributable to the failure of the enumerators in many of these cases to insert a sign denoting no children in the corresponding space when the woman had no children from her current marriage.[2] A substantial adjustment for this error would therefore be (a) to consider the excesses in durations 0–4 and 5–9 over the percentage in durations 10 and over, namely 4.35, as resulting solely from this error and consequently (b) to shift the two excesses into their corresponding cells (*i.e.,* durations 0–4 and 5–9) in the zero children category. This adjustment is not quite complete, however, because among durations 10 and over there still is an unknown number of childless women classified as "number of children

[2] The same error was observed in several other countries. For example, it was found that in the 1940 census of the United States the proportion of non-reports on children ever born was 12.6 per cent. In that census no instructions were given as to the proper entry for childless women. In the 1950 census a check box was provided on the census schedule for replies of "None." The proportion of non-reports in that census was 9 per cent.

Age	Percentage of Women With "Number of Children Not Given"
Under 20	34.59
20–24	21.89
25–29	13.64
30–34	11.13
35–39	8.98
40–44	10.37
45–49	8.91
50–54	12.15
55–59	8.54
60–64	12.37
65 and Over	13.90
Not Given	33.35

Table 2. Percentage of women classified in the 1947 Census of Egypt as "number of children not given," by age of women.

not given" because of the same error. The correction that has been made increases the total number of childless women from 408,063 to 574,651.

A similar adjustment was found necessary, for the same reason, in the census table giving the number of children by age of woman in 1947, in which we find the following proportions of women with "number of children not given." (Table 2.)

Here again we notice outstandingly high percentages in the first two intervals. We also find that the percentages among 25 and over are relatively high in comparison with their correspondents in the case of marriage duration. The reason for the latter observation—as well as for the first—is in all probability the same as before, namely failure to insert the sign denoting zero in the case of a childless woman. It is obvious that since the number of childless women is higher among ages 25 and over than among durations 10 and over (owing to remarriage and late marriage), the above error should happen more frequently among ages 25 and over than among durations 10 and over. Adjustment for this error must consequently be carried out in all age intervals rather than in the first two only as we did in the case of duration. The adjustment was made as follows: (a) Since the marginal distribution of married women

according to their number of children should be the same in the age table as in the duration table, the adjusted number of childless women in the age table should be raised to 574,651. This rise is brought about by shifting, as in the case of duration, 166,588 women from the "number of children not given" category into the zero children category. (b) The frequencies in each age cell in the "number of children not given" category are reduced by certain amounts and their correspondents in the zero children category are raised by the same amounts in such a manner as to yield equal percentages of women with "number of children not given" in each age interval and at the same time lead to a total shift of 166,588 women.

A possible explanation of the fact that 10.1 per cent of the married women were in the "duration not given" category as compared with only 0.3 per cent in the "age not given" category is that the census questions were answered by neighbors who were able to estimate the women's ages but not their marriage durations. This view is strengthened by the observed excess, as compared with the trend, in the percentage of women with number of children not given in the age intervals including a multiple of 10 in the preceding table. The excess indicates that the neighbor has estimated the woman's age in terms of multiples of 10, which are most frequently used in age estimation, but refrained from giving the harder-to-know number of children ever born to her during the current marriage. This explanation cannot be confirmed, however, without knowledge of the field operations of the census.

The third adjustment is in the table giving the number of children by marriage duration. It is required by the observed increase with the number of children of the proportion of women for whom the marriage duration is not given as shown in Table 3.

The available data do not seem to throw any light on the reason for this systematic increase. It cannot, for example, be attributed to decreasing ability on the part of the woman to give her marriage duration as she advances in age because, as

Number of Children	Percentage of Women with Duration of Marriage Not Given	Percentage of Women with Age Not Given
0	1.8	0.37
1	2.4	0.26
2	3.6	0.21
3	4.6	0.17
4	5.6	0.16
5	6.5	0.16
6	7.2	0.14
7	7.5	0.16
8	8.4	0.15
9	9.2	0.17
10 and Over	10.7	0.18
Not Given	59.1	0.75
All Women	10.1	0.28

Table 3. Percentage of women in the 1947 Census of Egypt with duration of marriage and age of women not given, by number of children.

we can see from the table, no similar increase with the number of children existed in the case of women for whom the age was not reported. In fact the percentages in the latter case show a systematic decrease up to six children. Nevertheless, the women with duration not given cannot be discarded from the table giving number of children by marriage duration because we would then be excluding a more reproductive group. In this situation the most plausible adjustment is perhaps to distribute these women proportionately over the marriage duration cells. For example, in the group of women who had one child the adjustment would be to take the members for whom duration was not given and distribute them over the durations 0-4, 5-9, . . . according to the reported proportions of females in these intervals.

The two adjusted tables were utilized to calculate the duration specific and age specific cumulative reproduction rates. The rates are given in Tables 4 and 5 respectively.

We have no means of testing the accuracy of reporting beyond the above discussed adjustments. However, the average number of children does taper off to a reasonable extent toward

Marriage Duration	Cumulative Reproduction Rates
0–4	.64
5–9	2.18
10–14	3.77
15–19	5.05
20–24	5.85
25–29	6.61
30–34	6.69
35–39	7.08
40–44	7.06
45 and Over	7.42
All Durations	3.66

Table 4. Duration specific cumulative reproduction rates.

the end of each of Tables 4 and 5, which is what we would expect under unchanging fertility. (For a discussion of the stability of fertility in Egypt, *see* El-Badry: "Some Demographic Measurements for Egypt," Milbank Memorial Fund *Quarterly*, July, 1955.) Therefore, we can at least say that, among women aged 45 and over, there is no indication that a woman was more apt to forget the number of her children as she advanced in age.

Differential Fertility by Geographic Regions

For the purposes of this study, the only possible way of sepa-

Table 5. Age specific cumulative reproduction rates.

Age	Cumulative Reproduction Rates
Under 20	.41
20–24	1.19
25–29	2.38
30–34	3.52
35–39	4.75
40–44	5.25
45–49	6.00
50–54	5.68
55–59	6.40
60–64	5.82
65 and Over	5.96
All Ages	3.66

rating urban and rural data in the available tables is to divide the whole country into two sections: (1) urban including the five governorates (cities) and (2) predominately rural including the provinces. Now since we have no access to cross-classifications of reproduction, marriage duration, and age for geographic sections, the reproduction of two sections can be compared only by averaging the data supplied by the three univariate tables mentioned before, namely the distributions of married women in 1947 according to number of children born during the current marriage, duration of marriage, or age.

When we start to calculate the average number of children per married woman in each of the two sections we find ourselves confronted again with the above discussed deficiency in the number of childless women due to the insertion of some of them in the "number of children not given" category. The averages are found to be 3.61 in the governorates and 3.68 in the provinces, if we assume that the proportion to be shifted from the "number of children not given" category into the zero children category because of this error is the same in the two sections. We have no way of judging the validity of this assumption, but the fact that the proportion of all women with "number of children not given" is 12 per cent in the governorates and 14 per cent in the provinces suggests a higher degree of incidence of this error in the latter section. If we attribute this excess of 2 per cent in the provinces to this error only, shift it to the zero children category, calculate the remaining frequency that should be shifted to that category, and distribute it over the two sections according to the total number of women in each, we find that the average number of children per married woman becomes 3.65 in the cities and 3.66 in the provinces.[3]

It is thus obvious that no matter what the extent of this error is, the excess reproduction in the provinces over the governor-

[3] In calculating the average reproduction, a mean value of 12 children for the interval 10 and over was assumed. It was found that a mean value of 11 would still keep the difference between the provinces and governorates well below .1 children. A mean value larger than 12 would reduce even further the calculated difference because of the existence of a larger proportion of women with 10 or more children in the governorates.

ates is in all probability below .1 children per married woman. The standard error of difference is less than .005.

Let us now compare the durations of marriage in the two communities. First we find that the observed high percentage of women with unknown duration, being practically the same in the two communities, is unlikely to affect the difference between average durations. We also find that in order to calculate the average durations we have to assume a mean value for the duration interval 45 years and over. If, for example, we assume that this mean value is 55 years we get average durations of marriage equal to 13.1 and 14.7 years in the governorates and the provinces respectively. The mean value of 55 years, though plausible, may seem rather arbitrary. However, since there exists a larger proportion of marriages of duration 45 years and over in the provinces, a lower limit for the difference between the two averages can be obtained by differencing the average durations for marriages that lasted less than 45 years up till the census. The latter difference is found to be 1.3 years. (The averages for marriages of duration below 45 years are 12.9 years in the governorates and 14.2 years in the provinces.)

Thus, while the rural section of the population has an average excess of over 1.3 years of married life for each marriage that existed in 1947, it has produced an excess of at most .1 children on the average during that marriage. Needless to say, the two figures do not show any excess in rural fertility over that of the urban areas.

One should be careful, however, in interpreting these figures, since the above argument ignores the differences in age distribution of married women in the two sections of the population.

This difficulty can be avoided by examining an urban and a rural community, Alexandria and Sharkia, where only slight differences exist between age and duration distributions of married women in the two communities. The age distributions are as shown in Table 6. The effect of the slight discrepancy between the two distributions on reproduction can be figured by calculating a standardized average number of children per cur-

Age	Percentage Age Distribution	
	Alexandria	Sharkia
Under 20	6.7	5.4
20–29	33.9	33.3
30–39	31.0	31.4
40–49	17.9	18.8
50 and Over	10.5	11.1

Table 6. Percentage age distribution by age of women in Alexandria and Sharkia.

rent marriage in 1947 in each of the two communities. This can be done by weighting the frequency in each age interval by the average number of children born to women in the same interval in the whole country, as given by Table 5. This procedure will give standardized averages equal to 3.51 in Alexandria and 3.64 in Sharkia. The age distribution in Sharkia is thus favorable to an excess of .1 children per married woman if the women in the two communities are reproducing at rates equal to those of the whole country.

Moreover, the distributions of the same women according to marriage duration are practically identical. (Table 7.) When the two distributions are weighted by the average number of children per marriage in the whole country for each duration,

Table 7. Percentage distribution of women in Alexandria and Sharkia by duration of marriage.

Marriage Duration	Percentage Distribution	
	Alexandria	Sharkia
0–4	26.5	25.0
5–9	20.6	20.5
10–14	15.4	16.5
15–19	12.3	12.7
20–24	11.3	10.2
25–29	5.7	5.9
30–34	4.6	4.9
35–39	1.7	1.7
40–44	1.4	1.7
45 and Over	.6	1.0
Total	100.1	100.1

as given by Table 4, the resulting standardized average number of children per marriage is found to be 3.43 in Alexandria and 3.49 in Sharkia, which are very nearly equal; the duration distribution in the latter being favorable to a very slight excess in reproduction.

We thus have for comparison an urban and a rural community both of which are reasonably large (Alexandria had 153,594 women of given marriage duration in 1947 while Sharkia had 248,180) and which have nearly the same age and duration distributions. The data on reproduction in the two communities give the averages of 3.59 and 3.23 children per married woman in Alexandria and Sharkia respectively.[4] When we consider that the slight discrepancies between the age and duration distributions favor higher reproduction in Sharkia, we find it hard to avoid coming to the conclusion that the two figures obtained on average reproduction do not support the presumption of lower marital fertility of women in urban than in rural areas.

Attention may now be turned to comparison of reproduction in the governorates and the provinces. Here we find that the duration of marriage is favorable to larger reproduction in the provinces. This is indicated, as said before, by the excess duration of more than 1.3 years in the former. It is also demonstrated very clearly by the percentage distributions of married women in 1947 according to their duration of marriage (Table 8), where the governorates obviously outrank the provinces with respect to proportion of recent marriages, *i.e.* those contracted within the previous ten years.

One can assert further that marriage duration is favorable to higher reproduction in the provinces by calculating the stand-

[4] The two averages are adjusted for the insertion of some women actually belonging to the zero children category in the "number of children not given" category. The adjustment was to shift the same percentage as was adopted before for the whole country from the latter category into the former. The average for Sharkia would be reduced—and the difference between the averages in the two communities would consequently be increased—if we shift a higher percentage in the case of Sharkia to allow for the observed higher percentage of women with "number of children not given," which is equal to 16.8 per cent as compared to 13.0 per cent in Alexandria.

Marriage Duration	Percentage Distribution of Married Women	
	Governorates	Provinces
0–4	28.1	23.4
5–9	21.0	19.1
10–14	15.1	15.7
15–19	11.7	13.0
20–24	10.4	11.3
25–29	5.8	6.5
30–34	4.4	5.6
35–39	1.7	2.2
40–44	1.3	2.0
45 and Over	.6	1.2
Total	100.1	100.0

Table 8. Percentage distribution of married women by duration of marriage, in the governorates and provinces of Egypt, 1947.

ardized average number of children per married woman that would result if the women given by the above two distrbiutions were reproducing at the rates given by Table 4 for married women in the whole country. The standardized averages are found to be 3.34 in the governorates and 3.67 in the provinces.

Let us now compare the age distributions of married women in 1947 in those two sections of the population. The percentage distributions are as shown in Table 9. If the reproduction rates are the same then one would expect the age distribution in the provinces to be favorable to higher reproduction because it has a larger proportion of women aged 30 and over. The evidence is strengthened when we weight the above proportions by the average number of children per woman in each age group, as given by Table 5, and get the standardized averages of 3.40 in the governorates and 3.71 in the provinces.

To summarize the available information: On the one hand, when we standardize the number of children per marriage in the urban and rural sections by means of weights obtained from the reproduction of the two communities together, we find that, other factors affecting reproduction remaining equal, age and duration distributions acting separately are each favor-

Age	Percentage Distribution of Married Women	
	Governorates	Provinces
Under 20	8.06	5.44
20–24	16.98	13.24
25–29	18.72	18.17
30–34	15.79	16.17
35–39	14.21	15.28
40–44	10.34	11.38
45–49	6.80	8.30
50–54	4.87	5.75
55–59	1.90	2.62
60–64	1.48	2.14
65 and Over	.86	1.52
Total	100.01	100.01

Table 9. Percentage age distribution of married women in the governorates and provinces of Egypt, 1947.

able to an excess of .3 children per marriage in the rural section. On the other hand, data on reproduction show an excess not larger than .1 children with a standard error less than .005 in the latter section. Thus these results fail again to support the assumption of higher fertility of married women in rural than in urban Egypt.

The same story is repeated when we compare Cairo with the rest of the country. Again we find that married women in Cairo are younger and that the difference in age distribution leads to a deficiency there equal to .34 children per marriage if the rates for the whole country are applied. (The standardized averages there are 3.35 in Cairo and 3.69 in the rest of the country.) We also find the duration of current marriage shorter in Cairo, leading to a deficiency of .36 children per marriage when the frequencies in each duration are weighted by the rates of the whole country. (The standardized average number of children in this case is 3.29 in Cairo and 3.65 elsewhere.)

Thus, while the differences in age and duration distributions lead to deficiencies in Cairo of .34 and .36 children per marriage respectively if the rates for the whole country are applied, data

on reproduction show a deficiency of only .09 children per marriage there. (The average number of children per marriage is 3.58 in Cairo and 3.67 elsewhere.)[5] The remaining part of the deficiency, namely over .2 children per marriage, could not be accounted for if Cairo had lower fertility than the rest of Egypt.

The results so far obtained can be summarized as follows: Unless the degree of understatement of the number of children ever born to rural women was higher than that among urban women, there is nothing in the available census material to support the assumption that fertility of married women is lower in urban than in rural Egypt.

Differential Fertility by Occupation

As already stated, the 1947 census tabulations on fertility do not include the occupation of the father. However, owing to the importance of this question which might indicate the prospects of growth within the different classes and whether any class is practicing fertility limitation in any form, use will be made here of a table published in the 1947 *Vital Statistics* entitled "Live births by order and occupation of father." The table includes fathers of the 352,000 births of known order that took place during 1947 in the Health Bureau areas.

It goes without saying that the data given by such a table do not represent absolute fertility because they pertain to the reproduction of a group of married men who had births in a certain year—thus excluding the childless. Even with respect to relative fertility, the table ignores the possible class differences in interruption of married life by widowhood, divorce, and separation. One must also be aware of the uncertainty, in some of the cases, as to whether the reported order of birth was based upon the aggregate offspring of the father rather than upon those born during the current marriage only. Besides, there is

[5] The frequency in the zero children category was adjusted, as before, by adding to it, in each of the two communities, the same percentage of women with "number of children not given" as was adopted before for the whole country. The average number of children in the rest of Egypt and its difference from that in Cairo will both be reduced if a higher percentage is adopted in the case of the rest of Egypt to allow for the observed higher percentage of women with "number of children not given," which equals 14.2 per cent as compared to 12.2 per cent in Cairo.

evidence that the frequencies of births of first and second order, as given by the table, are below reality in all occupational groups. However, we will attempt here to condense the information supplied by the table and then draw whichever conclusions that seem safe.

The 76 occupations given in the original table have been condensed for the purposes of this study into ten occupation groups. Each group was designed to include occupations of the same general nature and to increase the likelihood that the person had spent all his reproductive life in the same group. The ten broad occupation groups are as follows:

1. Agricultural laborers. Those include the paid laborers as well as those who cultivate their own land or that of the members of their families.
2. Nonagricultural laborers. This category has by far the widest variety of employments. Besides all sorts of manual nonagricultural laborers, the group contains drivers, coachmen, sailors, nurses, porters, shop assistants, peddlers, waiters, and servants.
3. Policemen and messengers.
4. Merchants. This category includes all kinds of traders, commission agents, brokers, auctioneers, and contractors.
5. Religious employees. All kinds of priests, preachers, mosque and church assistants, and Moslem judges were grouped together in order to form a category which could be presumed to be virtually noncontraceptive.
6. Teachers.
7. Lawyers, prosecutors, and judges.
8. Journalists, authors, actors, and musicians.
9. Administration officers, comprising clerks, computors, secretaries, supervisors, and top officials, both in civil service and in private business.
10. Engineers, doctors, officers, and technicians.

The occupations under 10 were combined because they were found to possess very similar reproduction and also because they have similar economic and educational standards. Occupations 6, 7 and 8 were left separate despite their comparatively

Occupation Group of Father	Number of Fathers of 1947 Births	Average Number of Children Ever Born to 1,000 Fathers of 1947 Births	Standard Error of the Average
1. Agricultural Laborers	65,294	3,899	10
2. Nonagricultural Laborers	156,113	3,879	7
3. Policemen and Messengers	14,992	3,951	20
4. Merchants	53,860	4,105	11
5. Religious Employees	2,056	4,407	60
6. Teachers	5,562	4,124	33
7. Lawyers, Prosecutors, and Judges	574	3,814	99
8. Journalists, Authors, Actors, and Musicians	725	3,852	88
9. Administrative Officers	31,927	3,806	14
10. Engineers, Doctors, Officers and Technicians	4,607	3,455	33

Table 10. Differential reproduction by father's occupation.

small sizes because they had distinct reproduction which would be obscured if they were added to group 9 or 10.

A number of minor occupations appearing in the original table and comprising 15,022 individuals were not included in the condensed groups 1–10 for one of the following reasons: (1) Two or more heterogeneous employments were grouped together under one title in the original table. An example of this is the grouping of teachers of penmanship and Koraan in the villages together with the teachers of athletics, music, and dancing in the regular and higher schools. Another example is that of the guards who can be either urban or rural. (2) The members of an occupation are known to be advanced in age and yet cannot be attached to any of the major employments. Examples of this case are village mayors, tribal chiefs, and landlords. Another 1,568 births were added to the excluded group because the father or his occupation was unknown.

The reproduction of these occupation groups is given in Table 10 where the average number of children is calculated by averaging the orders of children born in 1947 for each group.

It is obvious that since all fathers under consideration belong to Health Bureau areas, the occupational distribution in the table is not representative of the whole country. Consequently, no total rates are presented.

If we assume similar accuracy of reporting among agricultural and nonagricultural laborers, we come to the interesting result that the reproduction of the two groups is practically the same. The observed difference of 20 children per thousand fathers has a standard error of 11.4 and cannot therefore be considered significant. The policemen and messengers, for whom the accuracy of reporting is not likely to differ greatly from the two groups of laborers, showed significantly higher reproduction. All or part of this excess may have arisen from difference in age.

When we compare the reproduction of the well educated groups—6, teachers; 7, lawyers, prosecutors, and judges; 8, journalists, authors, actors, and musicians; 9, administrative officers; and 10, engineers, doctors, officers, and technicians—who are all expected to have the same accuracy of reporting, we notice at once the very significantly higher reproduction of the teachers. It seems unlikely that the observed excess is attributable to differences in age because the teachers include the large group of young primary school teachers.[6] One might suspect that the reproduction of this group was inflated by the presence of the school administrative staff. Yet this suspicion does not seem to be justified because the occupation group of administrative officers (group 9 in Table 10), to which the school administration staff naturally belong, indicates a much lower reproduction than that of the aggregate group of teachers and administrative officers in schools. Next, and significantly lower in reproduction than the teachers and any of the groups 1–5, we find the three groups—7, lawyers, prosecutors, and judges; 8, journalists, authors, actors, and musicians; and 9, adminis-

[6] It was not possible to check the accuracy of this statement by means of the census age distributions because those distributions include all persons working in education, medicine, law, etc., a large number of whom are outside the occupations under consideration.

trative officers. The differences between the three groups were not significant. The reproduction of the tenth and final group, namely engineers, doctors, officers, and technicians is very significantly lower than that of any other group in the table. The observed difference between the last four groups, namely 7–10, and any other group in the table, except the teachers, should be even more significant if the tendency to leave out the dead children or to mention only those born during the current marriage decreases with education. However, one cannot deduce, without further evidence, that the low reproduction groups are deliberately practicing fertility control. Late age at marriage, because of extended education, may be a major factor in the observed lower reproduction.

Table 10 shows that the reproduction of religious employees is very significantly higher than any other group. They are followed by the merchants who again are significantly higher than the groups 1–3 and 7–10. The excess in reproduction of the religious employees and merchants over the educated groups 7–10 is, in all probability, true because difference in accuracy of reporting all children, live or dead, born during the current or previous marriages would still add to this excess. The observed excess cannot be conclusive, however, when we compare the reproduction of those two groups with that of the non-educated groups 1–3, because it may have arisen from better reporting among religious employees and merchants.

Completed Reproduction of a Married Woman

We shall estimate here how many births a married woman will have when she terminates her reproductive period in marriage. The census data give an average of 5.9 children born during the current marriage to women aged 45 and over in 1947. This figure does not represent the full number of progeny because it pertains to current marriages only, thus excluding the offspring by previous marriages. Steps (a) and (b) of the following procedure, which are adopted to estimate the reproduction in previous marriages, lead to the following estimated

percentage distribution of married women aged 45 and over according to civil status before their current marriage: 68.1 never married before, 24.4 divorced, and 7.5 widowed. It is thus 31.9 per cent of married women aged 45 and over who have had previous marital experience. The previous reproduction of the latter women should be estimated and pooled with the reproduction from current marriage of all married women aged 45 and over in order to estimate the completed reproduction of a married woman. This reproduction in previous marriages will be estimated as follows:

(a) The age at marriage for married women in each age interval above 45 years is calculated from the 1947 census table which distributes married women by age and duration of marriage. For example, the 80,511 women of age 50–54 and duration 30–34 were aged 15–24 at the beginning of their current marriage.

(b) By using the 1947 vital statistics table which distributes the women married in 1947 by age and civil status before marriage and assuming that this table represents approximately the status of women included in the table mentioned in (a) at the beginning of their current marriage, we can calculate the distribution according to civil status before the current marriage of the women aged 45 and over in each age-duration cell in the table referred to in (a). For example, the vital statistics table distributes the women married at ages 15–24 as follows: 88 per cent never married before, 11 per cent divorced and 1 per cent widowed. These percentages will give the distribution of the above mentioned 80,511 women of age 50–54 and duration 30–34 according to their civil status before their current marriage.

(c) For every duration-age cell in the table referred to in (a) we have thus far estimated the number of women married after divorce or widowhood and calculated their ages at the beginning of their current marriages. We proceed now to calculate their previous reproduction. This will be estimated for those married after divorce from the 1947 table which distributes the divorced women remarried in 1947 by age and number of children from previous marriages. (Table 11.) Given the

age of the divorced woman at remarriage and adopting the above averages as estimates of her previous reproduction, we can calculate the cumulative reproduction from previous marriage of married women in 1947 who were divorced before their current marriage. For example, the above mentioned 80,511 × .11 married women of duration 30–34 and age 15–24 at the beginning of their current marriage who were divorced before that marriage will have a previous reproduction equal to 80,511 × .11 × .18 where .18 is the average given by the table for the age interval 15–24.

It was not possible to find information in the published statistics that would throw light on the previous reproduction of women who were widows before their current marriage. Vital statistics, for example, do not include a table similar to the one utilized in the preceding paragraph to estimate the reproduction of previously divorced women. It is obvious, however, that there is no reason for expecting their previous

Table 11. Number of divorced women remarried in 1947 by age and average number of children from previous marriages.

Age	Number of Divorced Women Remarried in 1947	Average Number of Children from Previous Marriages
15–19	3,180	.08
20–24	16,801	.20
25–29	22,241	.41
30–34	12,228	.71
35–39	19,258	.85
40–44	10,131	1.16
45–49	4,766	1.42
50–54	2,288	1.60
55–59	808	1.79
60–64	278	1.97
65 and Over	27	2.30
All Ages	67,174	.56

The reader will notice that the averages provided by this table are low compared to those of currently married women of the same ages. This is due to: (1) Most of the divorced women have no or very few children. For instance, of the women divorced in 1947, 75 per cent had no children during their last marriage. This proportion ranged from 95 per cent in ages 15–19 to 65 per cent in ages 70–74. (2) An unmarried woman with no or few children is more likely to get remarried than one who has numerous children. (3) The women included in the table have not been reproducing during the period between the two marriages. (4) It is quite possible that the number of live children rather than that of children ever born was reported in some cases. This error is of unknown extent but it is not likely to affect the average completed progeny of married women calculated by averaging the pooled reproduction of all marriages.

reproduction to be lower than that given in Table 11 for divorced women. In fact, one would expect previous reproduction to be higher in the case of widows since the contributing factor in divorce, namely childlessness or few children, does not apply to widowhood. Therefore, by following the same procedure as in the preceding paragraph, we can calculate a figure which is in all probability not higher than the reproduction of previously widowed women in each age-duration cell from their preceding marriages. We can also obtain an upper limit of their previous reproduction by treating them as if they had passed the whole interval between the dates of their previous and current marriages with their deceased husbands. For example, according to this assumption, the above mentioned 80,511 women of duration 30–34 and age 15–24 at the beginning of their current marriage have a total previous reproduction equal to 80,511 × .01 × .95, where .95 is the average reproduction of married women in 1947 in the age interval 15–24.

We finally have access to the following information on the progeny of married women aged 45 and over: (1) total reproduction in current marriage, (2) estimated total reproduction in previous marriage broken by divorce, (3) two estimated limits of the total reproduction in previous marriage broken by death of the husband. By pooling the three kinds of reproduction we finally find that a woman who terminates her reproductive period in marriage has an average completed reproduction between 6.2 and 6.4 children.

Conclusion

The tables on reproduction, marriage duration, and age of married women in Egypt, supplied for the first time by the 1947 census, are undoubtedly a contribution to the study of fertility in Egypt. The tables are by no means adequate, however, when utilized to investigate differential fertility among sections of the population. The shortage of data necessitated the use of rather crude and lengthy procedures in this paper in order to secure some evidence of class fertility differentials. It would

have helped this study considerably if the number of children were cross-classified in the census by age of mother and duration of current marriage, for broad geographic regions as well as for occupation groups of the father.

No evidence was found in the census or vital statistics data to support the assumption of lower fertility in urban than in rural Egypt. Reproduction was found to be lower to some extent among a limited number of educated people in urban areas. On the average, a woman terminating her reproductive period in marriage was found to have had between 6.2 and 6.4 children.

The published data showed clearly that there were major problems in the execution of the census. It was found that in numerous cases the enumerators simply failed to insert a mark denoting zero children and hence necessitated classification as "not given." It was also obvious that in an incredibly high percentage of the cases the census information was supplied by a neighbor or some person outside the family. This is clear from the fact that while over 10 per cent of the durations and 14 per cent of the numbers of children were not given, ages were lacking for only 3 per thousand of the women. Such errors in data collection not only reduce the amount of the available information but also give rise to serious hazards in interpretation.

References

1. 1947 Census of Egypt. Government Press, Cairo, 1953.
2. 1947 Vital Statistics of Egypt, Government Press, Cairo, 1952.
3. El-Badry, M. A.: Some Demographic Measurements for Egypt. Milbank Memorial Fund *Quarterly*, XXXII, No. 3, July, 1955, pp. 268–305.
4. 1950 United States Census of Population, Special Report P-E No. 5C-Fertility. United States Bureau of the Census, 1955.

SOCIAL AND PSYCHOLOGICAL FACTORS AFFECTING FERTILITY

XXX. EXTRA-FAMILIAL PARTICIPATION OF WIVES IN RELATION TO INTEREST IN AND LIKING FOR CHILDREN, FERTILITY PLANNING, AND ACTUAL AND DESIRED FAMILY SIZE[1]

LOIS PRATT AND P. K. WHELPTON

IT IS hypothesized that: "The extent of a wife's participation in activities outside the family is directly related to her interest in and liking for children and the effectiveness of her fertility planning, and inversely related to her fertility and desired family size.[2] Some assumptions underlying this hypothesis are briefly as follows: Outside activities are thought to affect a woman's interest in children in many ways—some tending to encourage her interest and others tending to discourage it. However, it is proposed that the positive influences are predominant. First, regular absences from the home may promote strong affection between mother and child because the mother's contact with the child does not consist primarily in *directing* the child. Since women with outside interests are not totally reliant on the family as an avenue of self expression they may be less likely to be bored with any facet of their lives and less likely to consider their children as a restriction. Some women who are active outside the home may also escape some of the drudgery of children by bringing in outside help. The time they spend at home may be spent in playing with, rather than working for, their children. The influence of the employed wife's earnings may be to prevent feelings of resentment of the sacrifices children entail. Participation outside the home also

[1] This is the thirtieth of a series of reports on a study conducted by the Committee on Social and Psychological Factors Affecting Fertility, sponsored by the Milbank Memorial Fund with grants from the Carnegie Corporation of New York. The Committee consists of Lowell J. Reed, Chairman; Daniel Katz; E. Lowell Kelly; Clyde V. Kiser; Frank Lorimer; Frank W. Notestein; Frederick Osborn; S. A. Switzer; Warren S. Thompson; and P. K. Whelpton.

[2] This is not one of the original hypotheses of the Indianapolis Study. It emerged from work on the Indianapolis hypothesis concerning the relationship of interest in children to fertility planning and size of planned family.

provides a general training in interpersonal relations, one aspect of which is the development of an enlightened interest in children as distinctive human beings whom it is pleasurable to watch develop. Outside experience may also teach the woman that role *alternatives* are available. The consequence of this may be that the decision to bear children becomes a more voluntary choice than submission to fate. This atmosphere may be conducive to attitudes of interest in and liking for one's children.[3]

Both negative and positive pressures operate to make a small planned family, and the desire for a small family, more likely among women who participate actively outside the home. The negative pressure is the competition for time, effort, and financial resources from the alternative activities; it creates a need to restrict the amount of family resources spent for children. The stimulus for family planning under these circumstances is to prevent becoming overburdened by children. The positive pressures include training in interpersonal relations and development of values about the obligations of parents to children. The influence of these experiences tends to be to make women undertake planning in order to further the interests of children and family.[4]

[3] The following studies provide relevant data concerning the relationship of outside participation to the wife's adjustment to her husband. The influence of outside participation on the husband-wife adjustment is probably similar in many ways to its influence on the mother-child relationship.

La Follette, C. T.: A Study of the Problems of 652 Gainfully Employed Married Women Homemakers, Columbia University, Teachers College Contributions to Education, No. 619, Teachers College, Columbia University, 1934. More than half the women studied reported they were better companions to their husbands because of having outside work.

Locke, Harvey and Mackeprang, Muriel: Marital Adjustment and the Employed Wife. *American Journal of Sociology*, LIV, 1949, pp. 536–538. No difference was found in the marital adjustment of women engaged in fulltime employment and women in fulltime homemaking.

Pratt, Lois: Student Marriages at Michigan State College. Unpublished Master's Thesis, Michigan State College, East Lansing, 1948. The wives who worked were better adjusted maritally than those who did not work.

[4] A previous article in this series contains evidence suggestive of this positive aspect of fertility planning motivation. It was shown that among couples who have children a strong interest in children is associated with effective fertility planning; other suggestive Indianapolis evidence was also cited.

Pratt, Lois and Whelpton, P. K.: Social and Psychological Factors Affecting

(Continued on page 46)

Since this is an *ex post facto* study no genuine test of causal hypotheses was possible. Nevertheless, it appeared desirable to propose that extra-familial participation may be the causal factor. In order to have a sounder basis for judging the plausibility of the suggested causal sequence, certain checks were made as follows. Extra-familial participation is thought to include several sub-elements, such as an adequate chance for self-expression and other value and behavior patterns discussed above as accounting for the relationship of social participation to liking for children and fertility behavior. Thus, if the causal implications of the hypothesis are correct, one should expect the sub-elements to be related to liking for children and fertility behavior in the same manner hypothesized for social participation. Measures of these sub-elements of social participation which were available were found to be related to liking for children, fertility planning and family size as predicted, thus lending some support to the reasoning underlying the hypothesis.[5]

1. The Data

The data pertain to the 1,309 couples with children in the inflated sample of 1,444 "relatively fecund" couples of the Indianapolis Study.[6] These couples were native white, Protestant,

Fertility. XXIX. Interest in and Liking for Children in Relation to Fertility Planning and Size of Planned Family. The Milbank Memorial Fund *Quarterly*, XXXIII, No. 2, October, 1955, pp. 430–464. (Reprint pp. 1211–1244.)

[5] The following measures were used to represent the elements subsumed under extra-familial participation:

"How good a chance do you have to express yourself?"

"How much has it bothered you to be tied down by your children?"

"Do you plan things in advance?"

"Which spouse should make the final decision whether to have another child?"

Amount of domestic help since the first child was born.

"How do you feel about childless families among couples in moderate circumstances?"

"Do you approve of a married woman with children holding a paid job?"

Before checking the relationship of these measures to liking and fertility behavior, a check was made which disclosed that these presumed sub-elements of social participation were closely related to social participation, providing some rationale for considering them to be included in this variable.

[6] All couples reporting four or more live births were classified as "relatively fecund" regardless of other circumstances. Couples with three or fewer live births were also classified as "relatively fecund" unless they knew or had good reason to believe that having a live born child was physiologically impossible during a period of at least 24 or 36 consecutive months since marriage (24 if never pregnant, 36 if

(Continued on page 47)

at least eighth grade graduates, married during 1927–1929, neither previously married, husband under 40 and wife under 30 at marriage, and residents of a large city most of the time since marriage.[7]

As in other articles in this series, four fertility planning categories are used. In descending order of success in fertility planning they are: Number and Spacing Planned, Number Planned, Quasi-Planned and Excess Fertility.[8] Fertility is represented by number of live births to the couple; the fertility rates used are the number of live births per 100 couples. Desired family size is represented by answers to the question "If you could begin your married life over again, and the size of your family could be determined by your liking for children, how many would you have?"

Childless couples (of whom there were 135) are not considered in the present study because the reasons underlying any relationship found between wives' extra-familial participation on the one hand, and their liking for children and fertility behavior on the other, may be quite different from those for couples with children. While no causal link is established here, it is suggested that the explanation for the relationships may lie in the influence of social participation on liking for children and fertility behavior. While it is possible that the influence is in the opposite direction even for couples with children, the suggested pattern seems totally inappropriate for childless couples, for there is an even greater liklihood that the childlessness and attitudes toward children of the latter group were prominent in establishing the wife's level of extra-familial participation.

ever pregnant). Failure to conceive in the absence of contraception practiced "always" or "usually" during periods of the above durations was considered "good reason" for such belief.

[7] A detailed account of the sampling procedure may be found in Whelpton and Kiser: Social and Psychological Factors Affecting Fertility. v. The Sampling Plan, Selection, and Representativeness of Couples in the Inflated Sample. The Milbank Memorial Fund *Quarterly*, January, 1946, xxiv, No. 1, pp. 49–93 (Reprint pp. 163–207).

[8] *See* Whelpton and Kiser: Social and Psychological Factors Affecting Fertility. vi. The Planning of Fertility. The Milbank Memorial Fund *Quarterly*, January, 1947, xxv, No. 1, pp. 63–111 (Reprint pp. 209–257).

The measures of extra-familial participation used here are work history and participation in the system of unpaid social activities, labeled here the "club" system. The three levels of business participation, labeled long, moderate, and none, are based on the number of years of full or part time employment since marriage. Long participation is five or more years, moderate is 1 to 4.9 years, and non-participation is less than one year or no work since marriage. Participation in clubs is measured by answers to the question, "Since your first child was born, how often have you gone to clubs, lodges, meetings, dances, parties, etc?" "Sometimes," "often" or "very often" represent participation; "seldom" or "very seldom" stand for non-participation.[9] The terms "Clubs" and "No Clubs" are used as a simple way of referring to these groups. While these terms do not adequately represent the two response groups, better designations were not at hand. It would have been preferable to measure club participation with questions on the amount of time devoted to different kinds of social activity at different times during marriage, as was done with work history.

The per cent distribution for each work group by "Clubs" and "No Clubs" is as follows:

Table A

	Number of Wives	Total	"Clubs"	"No Clubs"
Long Work	223	100	44	56
Moderate Work	388	100	46	54
No Work	698	100	48	52

Approximately the same proportion (somewhat under one-half) of each work history group participate in clubs, lodges, meetings, dances, parties, etc.

[9] Although it would have been desirable to keep those who "sometimes" participated in social activities separate from those who participated "often or very often," it was not feasible to do this. The cells were too small when the cross-tabulation by work history was made. The effect of retaining three work divisions but only two "club" divisions may be to accentuate unduly the importance of work in the findings. However, examination of results when three "club" groups are used suggests that separating the "sometimes" and "often or very often" groups would not significantly alter the results.

2. Extra-Familial Participation in Relation to Interests in and Liking for Children

It is found for the sample as a whole that women who participate outside the home are characterized, as hypothesized, by a somewhat higher degree of interest in and liking for children than women whose activities are restricted primarily to the home.[10] Both employment and participation in clubs, lodges, meetings, dances, parties, etc., are, to a slight degree, positively related to a woman's interest in and liking for children, as measured by the summary index of "interest," but these differences are not significant statistically. When combined into social participation "levels," these factors show a significant relationship to interest in children, as shown in Table 1. Women who engaged in both "club" and work activity have the highest level of interest in children, on the average; those who participated in only one of the systems or in both for a short period of time are intermediate in liking; and the women who participated in neither system have the lowest interest.

Looking again at Table 1, we see that the relationship of participation to interest in children is absent among effective planners and the Quasi-Planned, and negligible among the Excess Fertility group.

While the relationship of participation to liking is not sus-

[10] The questions used here to represent interest in and liking for children are:

1. "Do you get tired of hearing the constant questions children ask?"
2. "How does the fun you get compare with the trouble when children of your neighbors or friends come in and make themselves at home?"
3. "How much do you enjoy taking children on outings?"
4. "Do you like to play with, read or talk to children?"
5. "How much are you interested in hearing other people talk about their children?"
6. "Do you get as much "kick" from the things children say as from those grownups say?"
7. "Frequently children get so wrapped up in their play that they forget there is anyone around. Do you find it fun just to watch them then and see what they do and say?"
8. "How much did a strong liking for children encourage you to have your last child?"

A summary index of "interest" was devised, on which "Interest scores" for individuals range from 3 to 9 out of a possible range of 1 to 9. A high score represents high interest or liking. Correlations of individual items against the summary index range from +.40 to +.63. A Guttman scale was formed with these items with reproducibility of .76.

stained under control for planning status, it may be of interest to examine the relationship in more detail insofar as the findings may have implications for future work. It is possible that a closer link would be found between participation and the interest women show in their children through their actual be-

Table 1. Degree of interest in and liking for children (summary index) by extent of extra-familial participation, for all wives and by planning status.

Extent of Extra-Familial Participation	"Interest" Scores for All Wives and by Fertility-Planning Status[1]			
	All Wives	Number and Spacing and Number Planned	Quasi-Planned	Excess Fertility
Total	6.9	7.2	6.9	6.7
"Clubs"–Long Work	7.3	7.4	6.8	7.4
"No Clubs"–Long Work	7.0	7.3	6.7	6.6
"Clubs"–Moderate Work	7.0	7.0	7.2	6.6
"No Clubs"–Moderate Work	6.9	7.2	6.8	6.7
"Clubs"–No Work	7.0	7.0	6.9	6.9
"No Clubs"–No Work	6.8	7.2	6.9	6.5
Long Work	7.1	7.3	6.7	6.9
Moderate Work	6.9	7.1	7.0	6.6
No Work	6.9	7.1	6.9	6.5
"Clubs"	7.0	7.1	7.0	6.9
"No Clubs"	6.9	7.2	6.8	6.5
	Number of Wives			
Total	1,309	478	450	381
"Clubs"–Long Work	98	57	27	14
"No Clubs"–Long Work	125	73	29	23
"Clubs"–Moderate Work	178	68	63	47
"No Clubs"–Moderate Work	210	81	69	60
"Clubs"–No Work	334	124	127	83
"No Clubs"–No Work	364	75	135	154
Long Work	223	130	56	37
Moderate Work	388	149	132	107
No Work	698	199	262	237
"Clubs"	610	249	217	144
"No Clubs"	699	229	233	237

[1] The difference between the average interest scores of the "Clubs"–Long Work and the "No Clubs"–No Work groups is significant at the .01 level, for all planning categories combined.

havioral relationship to them, than the idealistic notions expressed in the present questions.

Of the eight items available for measuring interest in and liking for children, four are positively related to level of extrafamilial participation. They are:

> Do not tire of children's questions;
> More fun than trouble when neighbors' children visit;
> Encouraged to have children by liking for children;
> Like to watch children play.

The four remaining items show little or no relationship to social participation. Interest scores on each of the eight items are shown for the social participation groups in Appendix Table I.

The hypothesis assumes that the relationship between social participation and interest in children has a certain degree of independence from such variables as socio-economic status and family size; for these factors have not been subsumed, theoretically, under the social participation variable. In controlling the summary index of "interest" for socio-economic status it is found that the relationship is sustained in the upper and lower socio-economic groups, though not in the middle group. The difference is significant only in the lower status. Socio-economic status controls were also imposed on the individual liking item most closely related (positively) to socio-economic status. This item was "Not tire of children's questions." The relationship with social participation persisted but in a somewhat weaker form, particularly in the lower class. The relationship between participation and interest is undiminished under control for family size. (*See* Appendix Tables II and III.)

Some other factors which have been considered to be included in social participation should be found partially responsible for the relationship with interest in children. Such factors as education, the chance for self expression, and the amount of domestic help available were all suggested as reflections of certain aspects of the social participation complex. Control for edu-

cation reveals some irregularity in the college group but the relationship between participation and interest in children is

Table 2. Relationship between degree of interest in children and effectiveness of fertility planning, by extent of extra-familial participation.[1]

Degree of Interest in Children and Extent of Extra-Familial Participation	Number of Wives	Per Cent Distribution by Fertility Planning Status[1]				
		Total	Number and Spacing Planned	Number Planned	Quasi-Planned	Excess Fertility
"Clubs"–Long Work (Significant .01)						
High	40	100	56	17	10	17
Medium	37	100	44	13	30	13
Low	21	100	33	—	57	10
"No Clubs"–Long Work (Significant .02)						
High	45	100	47	22	18	13
Medium	45	100	47	22	18	13
Low	35	100	26	6	37	31
"Clubs"–Moderate Work (Significant .10)						
High	60	100	37	12	38	13
Medium	60	100	20	8	40	32
Low	58	100	24	14	28	34
"No Clubs"–Moderate Work (Significant .01)						
High	58	100	17	40	24	19
Medium	80	100	19	12	39	30
Low	72	100	17	15	33	35
"Clubs"–No Work (Significant .10)						
High	103	100	23	15	44	18
Medium	140	100	19	22	29	30
Low	91	100	15	15	46	24
"No Clubs"–No Work (Significant .001)						
High	100	100	11	18	39	32
Medium	122	100	8	18	43	31
Low	142	100	8	2	31	59

[1] The level of significance for the chi square tests of the relationship between interest and planning is shown for each social participation group.

undiminished among high school graduates and non-graduates. However, among women with a good or excellent chance for self-expression, and among those with considerable domestic help, the pattern is seriously weakened, though it persists in full force among women with fair-to-poor opportunities for self expression. That is, when good opportunities for self-expression or plentiful domestic help are present, interest in children tends to be quite high, regardless of the extent to which the woman participates in outside activities. But when the chance for self expression is not felt to be good or domestic help is not available, the woman's interest in children is dependent upon the extent of her social participation. To a certain extent, then, two of the subsidiary factors can serve the same function as social participation. (*See* Appendix Tables IV, V and VI.)

3. Interest in Children as Motivation for Fertility Planning

It was indicated in a previous article that nine out of ten of the couples who planned to be childless had little interest in children, but that among couples with children there was a tendency for strong interest in children to be accompanied by effective fertility planning.[11] The latter is consistent with the idea that planning tends to be employed as a means of promoting the best interests of one's children or the family as a whole. However, it was felt that this motivational pattern might not characterize women at all levels of social participation. Planning may not be closely related to liking among those whose activities are mainly restricted to the home, for these women may not have been trained to think of planning as a technique of effectuating their interest in children.

The data of Table 2 indicate that the positive relationship between liking for children and planning characterizes all participation levels. Chi squares for four of the groups are clearly significant (at .02 to .001); for two they are significant at the .10 level.

[11] Pratt and Whelpton, *op. cit.*

4. Extra-Familial Participation in Relation to Effectiveness of Fertility Planning

The data indicate that the higher the level of the wife's participation in activities outside the family the greater the probability of effective fertility planning. The hypothesis is, thus, sustained. Both work and "club" activity are related to planning. The association between a long work history and effective planning is notable.[12] As seen in Table 3, 46 per cent of the women with long work history plus "club" activity planned the number and spacing of their pregnancies, while only 9 per cent of the women participating in neither system did so. The proportions of the most active group and the non-participants who were unsuccessful in planning their family size are 14 and

Table 3. Effectiveness of fertility planning by extent of extra-familial participation.[1]

Extent of Extra-Familial Participation	Number of Wives	Per Cent Distribution by Fertility Planning Status				
		Total	Number and Spacing Planned	Number Planned	Quasi-Planned	Excess Fertility
Total	1,309	100	21	15	35	29
"Clubs"–Long Work	98	100	46	12	28	14
"No Clubs"–Long Work	125	100	41	18	23	18
"Clubs"–Moderate Work	178	100	27	11	36	26
"No Clubs"–Moderate Work	210	100	18	21	33	28
"Clubs"–No Work	334	100	19	18	38	25
"No Clubs"–No Work	364	100	9	12	37	42
Long Work	223	100	43	15	25	17
Moderate Work	388	100	22	16	34	28
No Work	698	100	14	15	37	34
"Clubs"	610	100	26	15	35	24
"No Clubs"	699	100	17	16	33	34

[1] The chi square is significant at the .001 level ,even when reduced by .4, the amount of sample inflation.

[12] As noted earlier, combining the women who attended clubs, lodges, meetings, dances, parties, etc. "sometimes" with those who attended "often" or "very often" may have artificially reduced the importance of this type of activity compared to the importance of work, where a three-way breakdown was used.

42 per cent respectively. Women with moderate participation outside the home are intermediate in planning effectiveness.

Considering this finding that participation is positively related to fertility planning in conjunction with the finding from a previous article that liking for children is positively related

Table 4. Effectiveness of fertility planning by extent of extra-familial participation, controlled for socio-economic status.

Extent of Extra-Familial Participation and Socio-Economic Status	Number of Wives	Per Cent Distribution by Fertility Planning Status[1]				
		Total	Number and Spacing Planned	Number Planned	Quasi-Planned	Excess Fertility
Upper Status						
"Clubs"–Long Work	49	100	60	4	18	18
"No Clubs"–Long Work	20	100	70	5	15	10
"Clubs"–Moderate Work	75	100	37	16	32	15
"No Clubs"–Moderate Work	53	100	21	28	32	19
"Clubs"–No Work	141	100	34	18	35	13
"No Clubs"–No Work	66	100	26	21	36	17
Middle Status						
"Clubs"–Long Work	16	*	*	*	*	*
"No Clubs"–Long Work	41	100	39	15	27	19
"Clubs"–Moderate Work	42	100	17	19	40	24
"No Clubs"–Moderate Work	47	100	21	15	41	23
"Clubs"–No Work	76	100	12	16	50	22
"No Clubs"–No Work	69	100	7	10	47	36
Lower Status						
"Clubs"–Long Work	33	100	33	9	37	21
"No Clubs"–Long Work	64	100	33	23	24	20
"Clubs"–Moderate Work	61	100	21	—	36	43
"No Clubs"–Moderate Work	110	100	15	20	30	35
"Clubs"–No Work	117	100	6	20	33	41
"No Clubs"–No Work	229	100	4	10	34	52

* Distributions are not shown for fewer than 20 wives.

[1] The differences between the proportions of the lowest and highest participation levels shown who were Number and Spacing Planned are significant at the .01 level for all socio-economic status groups. The differences between the lowest and highest participation levels shown with respect to the proportions who had Excess Fertility are also significant at the .01 level for the Middle and Lower Status groups but are not significant for the Upper.

to planning,[13] one might expect a close positive relationship between participation and planning, due to a joint influence of participation and liking on planning. This has been found to be the case. Referring back to Table 2, we see that the relationship between participation and planning is accentuated within groups with differing levels of liking for children.

Some indication of the social significance of extra-familial participation for fertility behavior is found in a comparison of Table 3 with the early Indianapolis Study findings for socio-economic status. About the same proportion of the active social participants as of the top socio-economic group had excess fertility.[14]

Table 4 provides indications of the combined influence of the two factors and the relative independence of the two influences. The following figures are relevant:

	Proportion Who Were Number and Spacing Planned:
Total Sample of Couples with Children	21
High Socio-Economic Status	44
Active Participants ("Clubs" – Long Work)	46
Active Participants and High Status	60

The independence of the two factors is striking and significant

[13] Pratt and Whelpton, *op. cit.*

[14] Effectiveness of fertility planning by socio-economic status.

Socio-Economic Status	Number of Wives	Per Cent Distribution by Planning Status				
		Total	Number and Spacing Planned	Number Planned	Quasi-Planned	Fertility Excess
1 (High)	201	100	44	16	27	13
2	203	100	29	21	37	13
3	291	100	18	14	42	26
4	372	100	16	12	35	37
5 (Low)	242	100	8	17	29	46

Kiser, Clyde V. and Whelpton, P. K.: Social and Psychological Factors Affecting Fertility. IX. Fertility Planning and Fertility Rates by Socio-Economic Status. The Milbank Memorial Fund *Quarterly*, April, 1949, XXVII, No. 2, pp. 184–244. (Reprint pp. 359–415.)

with respect to Number and Spacing Planned behavior, but rather uncertain for unplanned fertility.

5. Extra-Familial Participation in Relation to Fertility

In general, a high level of participation outside the home is accompanied by small family size, and a low level of participation by larger family size, as hypothesized. This holds true for the sample as a whole and for effective planners. Considering first the total group regardless of planning status, the following is found: both work and participation in clubs, lodges, meetings, dances, parties, etc. are accompanied by low fertility, work apparently being the stronger influence.[15] The greater divergence between the average fertility of workers and non-workers than between "club" and "non-club" women is accounted for by the tendency for work to be associated with a *single* child, and of "club" activity to be associated with *two* rather than three or more children. (*See* Table 5.)

Simultaneous consideration of work and "club" activity re-

Table 5. Fertility by extent of extra-familial participation.[1]

Extent of Extra-Familial Participation	Number of Wives	Per Cent Distribution by Family Size					Births Per 100 Wives
		Total	1 Child	2 Children	3 Children	4 or More Children	
Total	1,309	100	28	41	18	13	224
"Clubs"–Long Work	98	100	40	48	8	4	177
"No Clubs"–Long Work	125	100	54	31	11	4	166
"Clubs"–Moderate Work	178	100	34	44	14	8	199
"No Clubs"–Moderate Work	210	100	23	42	23	12	229
"Clubs"–No Work	334	100	26	47	16	11	218
"No Clubs"–No Work	364	100	17	36	24	23	272
Long Work	223	100	48	38	10	4	171
Moderate Work	388	100	28	43	19	10	215
No Work	698	100	21	42	20	17	246
"Clubs"	610	100	30	47	14	9	206
"No Clubs"	699	100	26	36	21	17	240

[1] The chi square is significant at the .001 level even when reduced by .4, the amount of sample inflation.

[15] Had it been possible to use three levels of "club" participation, as was done with employment, the importance of "clubs" might have been found to be somewhat greater than appears in the present data.

veals a more extreme pattern, particularly at the *inactive* end of the scale: all non-working wives have an average fertility of 2.46 children, while those who neither worked nor attended "clubs" average 2.72. However, at the high activity end of the continuum there is an exception to the general pattern: women with long work histories plus "club" activity tend to have somewhat *higher* fertility than women with long work alone. Particularly notable is the greater tendency of the Long Work–"No Club" women to have a single child than is true of the Long Work–"Club" women. Furthermore, the slightly lower fertility of the Long Work–"No Club" women cannot be accounted for by later marriage, postponement of births after marriage, more effective fertility planning, a lower level of interest in children, or a lower socio-economic status.[16] While the slightly lower fertility of the "No Club" working women has not been explained by these controls, the consistency of the finding has at least provided assurance that "clubs" do not have any further depressing effect on the fertility of women who worked several years after marriage. It may be that "club" activity emphasizes the importance of having a "normal" family of two children and thereby serves to *sustain* fertility against the further depressing influence of extensive employment. On the other hand, two children may serve as a greater stimulus than a single child for a working women to *enter* community or family-protective organizations.

The extent of extra-familial participation and degree of liking for children might be jointly related to fertility, since it was found in Section 2 that extra-familial participation is positively related to liking for children. However, it was found in a previous article that liking is not related to family size among women with children.[17] Hence the positive association between participation and liking does not affect the mode of relationship that participation has to fertility.

[16] These control tables are not shown in the present article. They are to be found in: Pratt, Lois: The Relationship of Non-Familial Activity of Wives to Some Aspects of Family Life. Unpublished Ph.D. Dissertation, University of Michigan, 1955.

[17] Pratt and Whelpton, *op. cit.*

The relationship of participation to fertility holds true for all planning status groups, as shown in Table 6. While the same general pattern of relationship prevails among effective planners as was found for all women combined, one exception is to be noted. In the entire sample, "club" women who did not work had lower fertility than "non-club" women with moderate work histories. The reverse is true for planners. That is, among those who undertake to plan their fertility, there is more limitation associated with work than with "clubs." This suggests that work may exert stronger pressure than "clubs" and that a

Table 6. Fertility by extent of extra-familial participation, for the planning status groups.

Extent of Extra-Familial Participation and Planning Status	Number of Wives	Per Cent Distribution by Family Size					Births Per 100 Wives[1]
		Total	1 Child	2 Children	3 Children	4 or More Children	
Number and Spacing and Number Planned[2]							
"Clubs"–Long Work	57	100	47	49	4	—	156
"No Clubs"–Long Work	73	100	63	30	4	3	147
"Clubs"–Moderate Work	68	100	40	53	4	3	174
"No Clubs"–Moderate Work	81	100	30	52	11	7	196
"Clubs"–No Work	124	100	16	64	16	4	208
"No Clubs"–No Work	75	100	27	41	21	11	221
Quasi-Planned							
"Clubs"–Long Work	27	100	37	56	7	—	170
"No Clubs"–Long Work	29	100	42	38	10	10	196
"Clubs"–Moderate Work	63	100	38	45	11	6	186
"No Clubs"–Moderate Work	69	100	29	43	19	9	209
"Clubs"–No Work	127	100	41	39	10	10	190
"No Clubs"–No Work	135	100	21	50	19	10	222
Excess Fertility							
"Clubs"–Long Work	14	*	*	*	*	*	278
"No Clubs"–Long Work	23	100	43	22	35	—	191
"Clubs"–Moderate Work	47	100	21	32	30	17	251
"No Clubs"–Moderate Work	60	100	7	25	45	23	296
"Clubs"–No Work	83	100	17	36	24	23	276
"No Clubs"–No Work	154	100	9	21	29	41	340

* Fewer than 20 wives.

[1] The differences between the fertility rates of the lowest and highest participation levels shown are significant at the .01 level for all planning status groups. (In testing the significance of the difference in the Quasi-Planned group, the "Clubs"–Long Work and "Clubs"–Moderate Work categories were combined.)

[2] The Number and Spacing Planned and the Number Planned groups were combined because the pattern is relatively the same for these two groups and the number of cases is too small to consider them separately.

woman may take more firm action to maintain work than "club" activity. The fact that the general relationship between fertility and participation persists among planners suggests that different requirements of the various roles demand certain family sizes—that fertility differences by participation are not merely due to differential knowledge of contraception. In a later section it will be shown whether different roles are also accompanied by differing desired family sizes.

The inverse relationship of fertility to social participation is not entirely due to a larger proportion of *incompleted* families

Table 7. Fertility by extent of extra-familial participation, controlled for socio-economic status.

Extent of Extra-Familial Participation and Socio-Economic Status	Number of Wives	Births per 100 Wives[1]
Upper Status	404	189
"Clubs"–Long Work	49	165
"No Clubs"–Long Work	20	145
"Clubs"–Moderate Work	75	179
"No Clubs"–Moderate Work	53	196
"Clubs"–No Work	141	194
"No Clubs"–No Work	66	217
Middle Status	291	213
"Clubs"–Long Work	16	169*
"No Clubs"–Long Work	41	224
"Clubs"–Moderate Work	42	198
"No Clubs"–Moderate Work	47	191
"Clubs"–No Work	76	204
"No Clubs"–No Work	69	245
Lower Status	614	252
"Clubs"–Long Work	33	200
"No Clubs"–Long Work	64	183
"Clubs"–Moderate Work	61	223
"No Clubs"–Moderate Work	110	260
"Clubs"–No Work	117	254
"No Clubs"–No Work	229	282

* Note that fewer than 20 wives are involved.

[1] The differences between the fertility rates of the lowest and highest participation levels are significant at the .01 level for all socio-economic status groups. (In testing the significance of the difference in the Middle Status group, the "Clubs"–Long Work and "Clubs"–Moderate Work categories were combined.)

among active women, for if we add another birth to the family size of all women who say they intend to have another child the pattern is still sustained. However, the relationship is weakened slightly because it is a little more common for the active than the inactive to say they plan to have another child.[18]

Table 7 shows that the relationship of extra-familial participation to fertility persists among all socio-economic status groups. Since the relationship of socio-economic status to fertility is also inverse, it is found that women who combine both high extra-familial participation and high socio-economic status have a fertiilty rate of 165, which is a little lower than the 177 for all active participants or the 189 for all upper socio-economic status women.

6. Extra-Familial Participation in Relation to Planning-and-Fertility Patterns

Another question of interest is the extent to which *patterns of planning-and-fertility* exist; that is, the extent to which effective planning and low fertility jointly characterize one social participation level, while ineffective planning and high fertility characterize another level. Table 8 shows the proportion of each social participation level who:

Planned the last child and had low fertility;
Planned the last child and had high fertility;
Did not plan the last child and had low fertility;
Did not plan the last child and had high fertility.

"Low fertility" is two or fewer children and "high fertility" is three or more children.

Effective planning (i.e. the successful planning of at least the

[18]

	Per Cent Intending Another Child:	Fertility Rate (Actual Plus Intended)
"Clubs"-Long Work	14	192
"No Clubs"-Long Work	8	173
"Clubs"-Moderate Work	3	201
"No Clubs"-Moderate Work	6	231
"Clubs"-No Work	6	219
"No Clubs"-No Work	4	273

Extent of Extra-Familial Participation	Number of Wives	Per Cent Distribution by Planning-and-Fertility Patterns[1]				
		Total	Planned-and-Low Fertility	Planned-and-High Fertility	Not Planned-and-Low Fertility	Not Planned-and-High Fertility
Total	1,309	100	30	6	38	26
"Clubs"–Long Work	98	100	56	2	32	10
"No Clubs"–Long Work	125	100	55	4	30	11
"Clubs"–Moderate Work	178	100	35	3	43	19
"No Clubs"–Moderate Work	210	100	31	7	33	29
"Clubs"–No Work	334	100	30	7	44	19
"No Clubs"–No Work	364	100	14	7	39	40

[1] All the differences between the proportions of high, moderate and low participation groups "planned-and-low fertility" are significant at the .01 level. The difference between the proportion of the low participation on group and other participation levels "not planned-with-high fertility" is also significant at .01.

Table 8. Planning-and-fertility patterns by extent of extra-familial participation.

last child) accompanied by low fertility is frequent in the two top participation groups, of average frequency in the next three, and infrequent in the lowest participation group. The reverse is true for ineffective planning with high fertility. We can say, then, that to a significant degree, women at different social participation levels are characterized by different reproductive patterns, including both planning and family size aspects.

7. Extra-Familial Participation in Relation to Desired Family Size

Desired family size is represented by women's answers to the question, "If you could begin your married life over again, and the size of your family could be determined by your liking for children, how many would you have?" Answers to this question reflect the number of children women desire *based on liking* rather than on the basis of all factors. For present purposes it would have been better if this question had read, "If you could relive your married life how many children would you want to have?"

The average size of family desired on the basis of liking for children is smaller for active social participants than for women with a low level of extra-familial participation. However, *all* groups express a desire for larger families than they have. Consequently, the differential among the social participation levels is not as great for desired as for actual family size.

Both work and "club" activity during marriage are slightly associated with small desired family size. Combining work and "club" activity into participation levels augments and clarifies

Table 9. Desired fertility and actual fertility by extent of extra-familial participation.

Extent of Extra-Familial Participation	Number of Wives	Per Cent Distribution by Desired Family Size					Fertility Rate[1]
		Total	1 Child	2 Children	3 Children	4 or More Children	
Total	1,309	100	2	39	22	37	316
"Clubs"-Long Work	98	100	2	41	24	33	313
"No Clubs"—Long Work	125	100	3	43	24	30	287
"Clubs"-Moderate Work	178	100	1	40	23	36	310
"No Clubs"-Moderate Work	210	100	-	41	25	34	323
"Clubs"-No Work	334	100	4	40	19	37	307
"No Clubs"-No Work	364	100	1	33	23	43	333
Long Work	223	100	3	42	24	31	300
Moderate Work	388	100	1	40	24	35	317
No Work	698	100	2	37	21	40	322
"Clubs"	610	100	3	40	21	36	309
"No Clubs"	699	100	2	36	24	38	323
	Number of Wives	Per Cent Distribution by Actual Family Size					Fertility Rate
		Total	1 Child	2 Children	3 Children	4 or More Children	
Total	1,309	100	28	41	18	13	224
"Clubs"-Long Work	98	100	40	48	8	4	177
"No Clubs"-Long Work	125	100	54	31	11	4	166
"Clubs"-Moderate Work	178	100	34	44	14	8	199
"No Clubs"-Moderate Work	210	100	23	42	23	12	229
"Clubs"-No Work	334	100	26	47	16	11	218
"No Clubs"-No Work	364	100	17	36	24	23	272

[1] The differences between the average desired size for the "No Clubs"-Long Work group and the "No Clubs"-No Work group is significant at the .01 level.

the nature of the relationship to desired family size. (*See* Table 9.) Only the women who participate in neither business nor "clubs" are distinguishable from other social participation groups in terms of family size preferences. The "No Club"–No Work women show a greater tendency to desire four or more children and a lesser tendency to desire two children than is true of all other participation levels, though the per cent differences are not statistically significant. The modal size preference for the non-participants is four or more children and for all other levels is two children. There are some other differences between participation levels in *average* fertility, but these differences are not reflected in a significantly greater tendency to prefer one particular family size rather than another. In terms of average desired fertility, the non-participants are highest; "club" women, regardless of work history, are intermediate, while women who worked several years but did not attend "clubs" are lowest. Taking the women's answers at face value, it may be that "club" activity reduces a woman's family size desires to a certain extent, but that it also serves to ward off the depressive influence of other forces, such as long employment. On the other hand, women who participate in "clubs" may simply be more likely to verbalize a high ideal family size, even when it is an unrealistic size for them.

Two other measures of family size values display the same inverse relationship with extra-familial participation level:

Table B

	Fertility Rate Based on:	
	Ideal Number of Children for a Couple in Moderate Circumstances	Number of Children Wanted at Marriage
"Clubs"–Long Work	225	230
"No Clubs"–Long Work	230	220
"Clubs"–Moderate Work	246	244
"No Clubs"–Moderate Work	261	255
"Clubs"–No Work	257	238
"No Clubs"–No Work	274	251

Examination of the relationship of participation to desired family size for the various planning status groups (Table 10) reveals that the pattern persists to a moderate degree among the Number Planned and among the Quasi-Planned. It is not

Table 10. Desired family size by extent of extra-familial participation for the planning status groups.

Extent of Extra-Familial Participation and Planning Status	Number of Wives	Per Cent Distribution by Desired Family Size[1]					Fertility Rate
		Total	1 Child	2 Children	3 Children	4 or More Children	
Number and Spacing Planned							
"Clubs"-Long Work	45	100	–	40	31	29	311
"No Clubs"-Long Work	51	100	4	49	29	18	261
"Clubs"-Moderate Work	48	100	–	42	37	21	283
"No Clubs"-Moderate Work	37	100	–	56	22	22	267
"Clubs"-No Work	64	100	6	36	19	39	325
"No Clubs"-No Work	32	100	–	40	38	22	287
Number Planned							
"Clubs"-Long Work	12	*	*	*	*	*	400*
"No Clubs"-Long Work	22	100	–	41	18	41	304
"Clubs"-Moderate Work	20	100	–	30	10	60	335
"No Clubs"-Moderate Work	44	100	–	9	32	59	434
"Clubs"-No Work	60	100	–	32	20	48	332
"No Clubs"-No Work	43	100	–	9	26	65	379
Quasi-Planned							
"Clubs"-Long Work	27	100	7	52	19	22	255
"No Clubs"-Long Work	29	100	–	48	7	45	310
"Clubs"-Moderate Work	63	100	3	45	13	39	319
"No Clubs"-Moderate Work	69	100	–	56	16	28	299
"Clubs"-No Work	127	100	2	53	19	26	289
"No Clubs"-No Work	135	100	2	37	18	43	310
Excess Fertility							
"Clubs"-Long Work	14	*	*	*	*	*	372*
"No Clubs"-Long Work	23	100	9	26	39	26	300
"Clubs"-Moderate Work	47	100	–	36	28	36	313
"No Clubs"-Moderate Work	60	100	–	37	33	30	303
"Clubs"-No Work	83	100	8	29	19	44	304
"No Clubs"-No Work	153	100	1	35	24	40	333

* Fewer than 20 wives.

[1] Combining the Number and Spacing and Number Planned groups, the difference between the fertility rates of the "No Clubs"-Long Work and the "No Clubs"-No Work women is significant at the .01 level. Neither this difference nor the difference between the fertility rates of the "Clubs"-Long Work and the "No Clubs"-No Work women is significant for the Quasi-Planned or Excess Fertility groups. For the combined Number and Spacing and Number Planned group, the differences in the proportions of the lowest and highest participation levels who have one child and in the proportions who have four or more children are significant at .01. For the Quasi-Planned, the corresponding differences are significant at .10 when the "Clubs"-Long Work and "Clubs"-Moderate Work categories are combined.

present among the Number and Spacing Planned and Excess Fertility groups.

The general relationship between average desired size and social participation level persists, by and large, in the middle and lower socio-economic status groups, but not in the upper status. (Appendix Table VII.)

Average desired family size is larger than average actual size for all social participation levels. If family size were determined only by liking for children, as reported by the respondents, there would be just over three instead of two children per couple in the sample. The difference is largely due to a smaller proportion of women desiring one child than actually having this number, and a larger proportion wanting four or more than actually having this family size. Fifty-eight per cent of the sample report that on the basis of liking they would have a larger family than they actually had.

That desired size is decidedly larger than actual size for every social participation level is clearly shown by the fact that the group with the highest actual fertility has a lower actual rate (272) than the lowest desired rate (287) of any of the groups in question. It is also indicated by the fact that the most com-

Table 11. Proportion who would have fewer, the same, or more children on the basis of liking than they actually have if they could relive married life, by extent of extra-familial participation.

Extent of Extra-Familial Participation	Number of Wives	Per Cent Who Would Like to Have:[1]			
		Total	Fewer	The Same	More
Total	1,309	100	10	32	58
"Clubs"–Long Work	98	100	2	27	71
"No Clubs"–Long Work	125	100	6	26	68
"Clubs"–Moderate Work	178	100	6	28	66
"No Clubs"–Moderate Work	210	100	10	32	58
"Clubs"–No Work	334	100	8	35	57
"No Clubs"–No Work	364	100	16	35	49

[1] The difference between the proportion of the highest and lowest participation levels wanting more children than they have is significant at the .01 level.

mon tendency of the women in every group is to state that they would like a family size larger than their own. (Table 11.)

But the participation levels differ in two ways: in the proportion who would like more children than they have, and (tentatively) in how great a discrepancy there is between the woman's actual and desired family size. Table 11 shows that the higher the participation level the larger the proportion who would like a family size larger than they actually have, and the smaller the proportion desiring a smaller family than their own. The question arises as to whether this greater interest of the high participation groups in a larger family than they have represents any real dissatisfaction with their fertility accomplishments, or whether it is only a difference between an ideal pattern and real life. Apparently a real desire to have a larger family is represented, for the higher the participation level the larger the proportion who would actually like to have another child.[19] This may indicate that participation has to a greater extent restrained the two most active groups from having their desired number of children than is true of less active groups. This finding is consistent with the notion that participation exerts an influence over fertility.

From the data at hand, it is not possible to conclude whether the difference among the participation levels in the proportion desiring a larger family is due only to the larger proportion of small families among the active participants, or whether, given a particular family size, the active participants are more likely

19

	Desire to Have Another Child
"Clubs"-Long Work	6.0
"No Clubs"-Long Work	5.9
"Clubs"-Moderate Work	4.9
"No Clubs"-Moderate Work	4.8
"Clubs"-No Work	4.7
"No Clubs"-No Work	4.5

Desire to have another child is expressed as an average score for each group and is based on the following weighted response categories of the question, "How much do you want another child sometime?"

Want very much	9
Rather want	7
Don't want but wouldn't object	5
Rather object	3
Very much against	1

Table 12. Desired by actual fertility for the extra-familial participation levels.[1]

Actual Family Size and Extent of Extra-Familial Participation	Number of Wives	Per Cent Distribution by Desired Family Size					Fertility Rate
		Total	1 Child	2 Children	3 Children	4 or More Children	
"Clubs"–Long Work							
1 Child	39	100	5	51	26	18	257
2	47	100	–	41	21	38	345
3	8	*	*	*	*	*	412
4 or More	4	*	*	*	*	*	350
"No Clubs"–Long Work							
1 Child	68	100	6	40	27	27	371
2	38	100	–	50	13	37	287
3	14	*	*	*	*	*	286
4 or More	5	*	*	*	*	*	320
"Clubs"–Moderate Work							
1 Child	61	100	3	53	23	21	282
2	79	100	–	40	23	37	299
3	24	100	–	25	33	42	286
4 or More	14	*	*	*	*	*	378
"No Clubs"–Moderate Work							
1 Child	48	100	–	77	13	10	233
2	87	100	–	37	24	39	323
3	49	100	–	20	49	31	374
4 or More	26	100	–	27	8	65	392
"Clubs"–No Work							
1 Child	86	100	13	54	10	23	250
2	159	100	1	45	22	32	298
3	53	100	–	23	32	45	246
4 or More	36	100	–	11	8	81	480
"No Clubs"–No Work							
1 Child	63	100	6	45	19	30	306
2	130	100	–	44	21	35	297
3	85	100	–	23	38	39	332
4 or More	86	100	–	19	16	65	413
Long Work							
1 Child	107	100	6	45	26	23	275
2	85	100	–	45	18	37	319
3	22	100	–	23	50	27	332
4 or More	9	*	*	*	*	*	333
Moderate Work							
1 Child	109	100	2	63	18	17	261
2	166	100	–	39	23	38	311
3	73	100	–	22	44	34	366
4 or More	40	100	–	20	7	73	403
No Work							
1 Child	149	100	10	50	14	26	274
2	289	100	1	45	21	33	297
3	138	100	–	23	36	41	337
4 or More	122	100	–	17	13	70	418
"Clubs"							
1 Child	186	100	8	53	18	21	261
2	285	100	1	43	22	34	306
3	85	100	–	21	34	45	353
4 or More	54	100	–	11	7	82	422
"No Clubs"							
1 Child	179	100	4	52	20	24	279
2	255	100	–	42	21	37	304
3	148	100	–	23	43	34	341
4 or More	117	100	–	22	13	65	397

* Fewer than 20 wives.

[1] The chi squares are significant at .01 for the extra-familial participation groups 3, 4, 5 and 6.

to be dissatisfied than are the non-participants. From the data of Table 12 it can be stated that among women with three or more children, a larger proportion of "club" than of "non-club" women would like a larger family than they have. Among those with one or two children, however, the reverse is true, with a smaller proportion of "club" women wanting more than they have. Women with long work histories who have two children tend to want larger families on the average than non-working women who have this same number of children. None of the above differences is significant, however. Combining "club" and work activity into extra-familial participation levels practically eliminates these differences. However, on the basis of the question about whether the woman wants another child, among those with one, two or three children, the higher the participation level the more likely a woman is to want another child. (*See* Appendix Table VIII.) There is, therefore, only limited evidence to suggest that, given a group of women *with a particular family size,* the proportion desiring more children than they have will be larger for those who participate in activities outside the home than for the non-participants.

In addition to the larger proportion of active participants who would like a bigger family than they now have, there is a suggestion that the discrepancy between desired and actual family size tends to be greater for an active non-family participant than for a less active woman. It can be shown from the figures in Table 12 that among women with *one* child, group 2 (active women) and group 6 (inactive women) are apt to desire three or more children, while groups 4, 5 and 3 (the moderately active) would like two children. The greater discrepancy between actuality and aspiration for women in the extreme participation levels may occur for somewhat different reasons. Women who work may wish they were not seriously curbed in family activities by the requirements of their role. The non-participant role, on the other hand, is adaptable to the care of several children. In fact, such a role may demand several children. If the children are not forthcoming—either

because fertility was restricted for financial or health reasons or because of sterility—the woman may feel pressures to fulfill the requirements of the role. Among women with *two* children, however, the discrepancy between desired and actual size tends to be no greater for a woman in one participation level than for one in another. That is, the proportion aspiring to four or more children is about the same for all groups. Both the contradiction between the findings for one and for two child women and the small number of cases involved suggest extreme caution in drawing any conclusions about the size of discrepancy between desired and actual family size for the participation levels.

It has been found, then, that the differential among the social participation levels is not as great for desired as for actual size. The difference between the average actual size of family of the high and low participation levels is 1.1 children, while the corresponding difference in desired size is only 0.5 children per couple. In actual size, there is a wide divergence among the participation groups in the proportion with an only child—from 54 to 17 per cent; in desired size, almost the same proportion of all groups report wanting only one child (no more than four per cent). And the groups are much more similar with respect to the proportion who would like to have three or more children than in the proportion who actually have this family size. (These comparisons can be made from Table 9.)

8. Conclusions

The extent of a wife's participation in activities outside the home is directly related to her interest in and liking for children and the effectiveness of her fertility planning, and inversely related to her fertility and desired family size, all as hypothesized. These relationships are independent of socio-economic status.

The relationship of the wife's social participation to interest in children does not persist under control for fertility planning status. It may be that while the active modern woman's actual behavioral relationship to her children has altered in accordance with her role, she has not yet been so fully trained to it that her

ideal patterns have also altered. The questions used here to measure interest in children do not reflect very well the concrete relationships between the mother and her child. They may reflect instead the vague and idealistic notions which she may hold somewhat apart from her actual behavior with her children. While there has been found to be some adjustment between attitude toward children and the role, it is possible that if more specifically behavioral measures of the mother-child relationship had been used, a closer tie between role and attitude would have been found.

The close relationship found between extra-familial participation and fertility planning may come about because of the joint influence of participation and liking on planning. In a previous article it was shown that liking for children is positively related to planning.

Actual fertility behavior is more closely bound up with the woman's role outside the family than are her values regarding fertility. This finding suggests that it has been necessary for the active modern woman drastically to scale down her fertility to meet the requirements of her role, but that she has not yet accomodated her fertility desires to quite as great an extent. Or it may be that the discrepancy between desired and actual size is due to the tendency to answer the question about desired size in terms of an unrealistic and stereotyped "ideal." The general American normative pattern portraying a family of several children apparently still has some influence on active modern women, though not to quite as great an extent as on women whose activities are restricted mainly to the home, as in the traditional role pattern. The most "modern" women in the sample have not, then, completed the transition to a thoroughly "modern" pattern of life, for their values have not caught up with their behavior.[20] On the other hand, our most "traditional" women may be in the process of change also, for their fertility has been reduced somewhat below the desired

[20] It is also conceivable that actual fertility has been reduced to an extent that is incompatible with the norms of family size; and that henceforth, families will tend to be larger—more in accordance with the norm.

family size. It would be of interest to discover whether a sample of women studied at the present time would reveal the same differences in desired family size based on level of extra-familial participation as was found in the Indianapolis sample, or whether ideal size of family has increased more among one participation level than another.

Appendix Table I. Types of interest in children[1] by extent of extra-familial participation.

	Long Work		Moderate Work		No Work	
	"Clubs"	"No Clubs"	"Clubs"	"No Clubs"	"Clubs"	"No Clubs"
Tire of Hearing Constant Questions Children Ask	7.1	7.5	6.9	6.8	6.9	6.1
Fun vs. Trouble when Neighbors' or Friends' Children Visit	6.8	6.3	6.3	6.2	6.3	6.0
Encouraged to Have Children by Strong Liking for Children	7.0	6.2	6.6	6.5	8.0	6.4
Interest in Hearing Others Talk about Their Children	6.5	6.9	6.7	6.9	6.3	6.3
Like to Watch Children Play	8.8	8.8	8.4	8.4	8.6	8.2
Like to Play with, Read or Talk to Children	7.3	6.9	7.1	6.8	6.9	7.1
Get As Much Kick from Things Children Say As From Those Grownups Say	7.7	7.8	7.4	7.7	7.5	7.6
Enjoy Taking Children on Outings	7.9	7.6	8.0	7.9	7.7	7.7

[1] The interest scores shown here represent the average response score on the given question. Responses to each question were coded 1, 3, 5, 7 or 9, with a high score signifying strong interest in children.

Appendix Table II. Degree of interest in children as determined by summary index and by replies to question "Do you get tired of hearing the constant questions children ask?" by extent of extra-familial participation, controlled for socio-economic status.

Extent of Extra-Familial Participation and Socio-Economic Status	Number of Wives[1]	Interest in Children: As Determined By	
		Summary Index Score	Replies To Question "Do You Get Tired of Hearing the Constant Questions Children Ask?"
Upper Status			
"Clubs"–Long Work	49	7.3	7.4
"No Clubs"–Long Work	20	7.5	8.0
"Clubs"–Moderate Work	75	7.1	7.3
"No Clubs"–Moderate Work	53	6.9	6.8
"Clubs"–No Work	141	7.0	7.0
"No Clubs"–No Work	66	7.0	7.0
Middle Status			
"Clubs"–Long Work	16	7.0*	7.3*
"No Clubs"–Long Work	41	6.9	7.3
"Clubs"–Moderate Work	42	6.8	6.9
"No Clubs"–Moderate Work	47	6.9	6.8
"Clubs"–No Work	76	7.0	6.8
"No Clubs"–No Work	69	7.0	7.2
Lower Status			
"Clubs"–Long Work	33	7.3	6.7
"No Clubs"–Long Work	64	6.9	7.4
"Clubs"–Moderate Work	61[1]	7.0	6.5
"No Clubs"–Moderate Work	110	6.9	6.8
"Clubs"–No Work	117	7.0	6.7
"No Clubs"–No Work	229	6.6	6.6

* Note that fewer than 20 wives are involved.

[1] The column showing number of wives applies to both types of scores, with the exception that two of the 61 wives in the "Clubs"–Moderate Work group of the Lower Status did not answer the question about "Tire of children's questions."

Appendix Table III. Degree of interest in children (summary index) by extent of extra-familial participation, controlled for family size.

Extent of Extra-Familial Participation and Family Size	Number of Wives	Interest Score
One Child		
"Clubs"–Long Work	39	7.3
"No Clubs"–Long Work	68	6.9
"Clubs"–Moderate Work	61	7.1
"No Clubs"–Moderate Work	48	7.0
"Clubs"–No Work	86	7.0
"No Clubs"–No Work	63	7.0
Two Children		
"Clubs"–Long Work	47	7.2
"No Clubs"–Long Work	38	7.2
"Clubs"–Moderate Work	79	7.0
"No Clubs"–Moderate Work	87	6.9
"Clubs"–No Work	159	6.9
"No Clubs"–No Work	130	6.6
Three or More Children		
"Clubs"–Long Work	12	7.5*
"No Clubs"–Long Work	19	7.1*
"Clubs"–Moderate Work	38	6.8
"No Clubs"–Moderate Work	75	6.8
"Clubs"–No Work	89	7.0
"No Clubs"–No Work	171	6.8

* Note that fewer than 20 wives are involved.

Appendix Table iv. Degree of interest in children (summary index) by extent of extra-familial participation, controlled for education.

Extent of Extra-Familial Participation and Level of Education	Number of Wives	Interest Score
College		
"Clubs"–Long Work	23	6.9
"No Clubs"–Long Work	16	7.4*
"Clubs"–Moderate Work	40	7.0
"No Clubs"–Moderate Work	21	7.5
"Clubs"–No Work	69	7.0
"No Clubs"–No Work	41	6.9
High School Graduate		
"Clubs"–Long Work	33	7.5
"No Clubs"–Long Work	53	7.1
"Clubs"–Moderate Work	58	7.1
"No Clubs"–Moderate Work	85	6.8
"Clubs"–No Work	112	6.9
"No Clubs"–No Work	94	6.9
Less Than High School Graduate		
"Clubs"–Long Work	42	7.3
"No Clubs"–Long Work	56	6.8
"Clubs"–Moderate Work	80	6.8
"No Clubs"–Moderate Work	104	6.8
"Clubs"–No Work	153	7.0
"No Clubs"–No Work	229	6.3

* Note that fewer than 20 wives are involved.

Appendix Table v. Degree of interest in children (summary index) by extent of extra-familial participation, controlled for chance for self-expression.

Extent of Extra-Familial Participation and Chance for Self Expression	Number of Wives	Interest Score
Good or Excellent Chance for Self Expression		
"Clubs"–Long Work	65	7.3
"No Clubs"–Long Work	78	7.1
"Clubs"–Moderate Work	109	7.1
"No Clubs"–Moderate Work	99	7.2
"Clubs"–No Work	204	7.2
"No Clubs"–No Work	142	7.1
Fair or Poor Chance for Self Expression		
"Clubs"–Long Work	33	7.1
"No Clubs"–Long Work	47	6.8
"Clubs"–Moderate Work	69	6.7
"No Clubs"–Moderate Work	111	6.7
"Clubs"–No Work	130	6.7
"No Clubs"–No Work	222	6.6

Appendix Table vi. Degree of interest in children (summary index) by extent of extra-familial participation, controlled for amount of domestic help.

Extent of Extra-Familial Participation and Amount of Domestic Help	Number of Wives[1]	Interest Score
Domestic Help Most of the Time		
"Clubs"–Long Work	35	7.3
"No Clubs"–Long Work	38	7.0
"Clubs"–Moderate Work	49	7.1
"No Clubs"–Moderate Work	37	6.9
"Clubs"–No Work	82	6.8
"No Clubs"–No Work	50	7.0
Seldom or Never Any Domestic Help or By Day Only		
"Clubs"–Long Work	62	7.2
"No Clubs"–Long Work	84	7.0
"Clubs"–Moderate Work	127	6.9
"No Clubs"–Moderate Work	172	6.9
"Clubs"–No Work	249	7.0
"No Clubs"–No Work	314	6.7

[1] Ten wives did not report the amount of help they had had.

Appendix Table VII. Desired family size by extent of extra-familial participation, controlled for socio-economic status.

Extent of Extra-Familial Participation and Socio-Economic Status	Number of Wives	Fertility Rate Based on Number of Children Desired[1]
Upper Status		
"Clubs"–Long Work	49	347
"No Clubs"–Long Work	20	310
"Clubs"–Moderate Work	75	301
"No Clubs"–Moderate Work	53	315
"Clubs"–No Work	141	306
"No Clubs"–No Work	66	308
Middle Status		
"Clubs"–Long Work	16	231*
"No Clubs"–Long Work	41	317
"Clubs"–Moderate Work	42	305
"No Clubs"–Moderate Work	47	392
"Clubs"–No Work	76	308
"No Clubs"–No Work	69	310
Lower Status		
"Clubs"–Long Work	33	309
"No Clubs"–Long Work	64	261
"Clubs"–Moderate Work	61	323
"No Clubs"–Moderate Work	110	340
"Clubs"–No Work	117	308
"No Clubs"–No Work	229	349

* Note that fewer than 20 wives are involved.

[1] Based on the question about the number of children the respondent would have on the basis of liking if married life could be relived.

Appendix Table VIII. Desire to have another child by extent of extra-familial participation, controlled for actual family size.

Extent of Extra-Familial Participation and Actual Family Size	Number of Wives	Desire to Have Another Child[1]
Women with One Child		
"Clubs"–Long Work	39	6.2
"No Clubs"–Long Work	68	6.4
"Clubs"–Moderate Work	61	5.7
"No Clubs"–Moderate Work	48	6.0
"Clubs"–No Work	86	5.5
"No Clubs"–No Work	63	5.6
Women with Two Children		
"Clubs"–Long Work	47	6.2
"No Clubs"–Long Work	38	5.8
"Clubs"–Moderate Work	79	4.7
"No Clubs"–Moderate Work	87	4.8
"Clubs"–No Work	159	4.5
"No Clubs"–No Work	130	4.8
Women with Three Children		
"Clubs"–Long Work	8	5.3*
"No Clubs"–Long Work	14	4.4*
"Clubs"–Moderate Work	24	4.2
"No Clubs"–Moderate Work	49	4.6
"Clubs"–No Work	53	4.3
"No Clubs"–No Work	86	4.1
Women with Four or More Children		
"Clubs"–Long Work	4	4.5*
"No Clubs"–Long Work	5	3.0*
"Clubs"–Moderate Work	14	3.9*
"No Clubs"–Moderate Work	26	3.6
"Clubs"–No Work	36	4.0
"No Clubs"–No Work	85	3.6

* Note that fewer than 20 wives are involved.

[1] Desire to have another child is expressed as an average score for each group and is based on the following weighted response categories of the question "How much do you want another child sometime?"

Want very much	9
Rather want	7
Don't want but wouldn't object	5
Rather object	3
Very much against	1

THE EFFECTS OF CHANGES IN MORTALITY AND FERTILITY ON AGE COMPOSITION

ANSLEY J. COALE[1]

THE age composition of any population is determined wholly by the past history of its births and deaths at each age, and by the number and age of the migrants who have entered or left the population. In the 19th century and the first half of the 20th, many national populations have been characterized by quite substantial changes in birth and death rates, and, inevitably, by considerable changes in age composition. Our purpose is to analyze as generally as we can the effects of changed vital rates on populations undisturbed by migration.

We cannot provide a usefully clear analysis of the general case of an arbitrary initial age distribution, arbitrary initial vital rates, and arbitrary vital rate changes. One reason that this case is too complicated is that the age distribution would typically change from its initial form even if the birth and death rates were to remain unaltered. In other words, most age distributions have unavoidable alterations built in—for example, a small cohort due to a pronounced birth deficit for a few years will remain smaller than neighboring cohorts as it becomes older and there will be a hollow moving out through

[1] Office of Population Research, Princeton University.

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The author felt impelled to work on this problem because of its implications for a research project on the relations between demographic change and economic development, a project supported in part by a grant from the International Bank for Reconstruction and Development. None of those who have helped or supported is, of course, in any way responsible for the shortcomings of the paper as published.

This paper is an extension of earlier work on the same problem. Much of the fundamental analysis is found in Alfred J. Lotka's publications, summarized in his THÉORIE ANALYTIQUE DES ASSOCIATIONS BIOLOGIQUES, 1939. Three recent articles anticipate our principal results, though they argue mostly by example rather than analytically. These articles are by Frank Lorimer, 1951; Alfred Sauvy, 1954; and the Population Division of the United Nations, 1954.

the age distribution with the passage of time. In order to isolate the effects of vital rate changes from these built-in changes, we will assume, for the most part in what follows, that the initial population has the so-called stable age distribution—a construct of population analysis partly originated and thoroughly explored by Lotka [Lotka, 1939]. The stable age distribution is the age distribution which would ultimately be established in a closed population if it maintained fixed schedules of fertility and mortality—the only age distribution with no built-in change.

Vital rate changes will be analyzed in two different ways. First, we will consider the ultimate age distribution which would arise from the indefinite continuation of new vital rates. This distribution is independent of the time sequence by which the rates are introduced. The first form of analysis will contrast, in other words, the new stable age distribution implicit in the new schedule of rates with the old distribution implicit in the old schedule. The second kind of analysis will explore the immediate effects of vital rate changes occurring in a particular time sequence. The ultimate stable age distribution is analogous to the "steady-state" response of a mechanical or electrical system to a new set of forces, while the changes in response to a particular sequence of rates resemble the transient characteristics of a physical system. The analogy suggests (correctly) that the steady-state response presents the easier problems to solve.

Throughout our discussion, the population considered will consist entirely of females: only female births, female fertility rates, and female deaths are treated. *Mutatis mutandis*, the same analysis would apply with equal validity to males. One needs to analyze the two sexes simultaneously only out of a concern for the logical consistency of the assumed vital rate changes for each sex. We will take advantage of the relative simplicity of analyzing one sex, and will consider as secondary such questions as the effect of the availability of spouses in determining fertility.

DIFFERENCES BETWEEN STABLE AGE DISTRIBUTIONS ARISING FROM DIFFERENT MORTALITY AND FERTILITY RATES

If the proportion of females born alive who survive to age a is l_a, and the probability of bearing a female child at age a is m(a), and if these functions remain unchanged, a constant rate of growth will eventually be established. The age distribution will become:

$$(1) \qquad c(a) = \frac{n(a)}{N} = \frac{e^{-ra}l_a}{\int_0^\omega e^{-ra}l_a da} = be^{-ra}l_a$$

where c(a) is the proportion of the female population at age a, n(a) is the number at age a, N is the total number of females, ω is the oldest age attained, r is the constant rate of growth finally established, and b is the female birth rate when growth rate has become r [Lotka, 1939].

The effect of the fertility schedule, m(a), in this scheme, can be seen when one considers that the product of the number of women at each age by the fertility schedule summed for all ages must equal the number of births.

$$\int_0^\omega c(a)m(a)da = b, \text{ or}$$

$$\int_0^\omega be^{-ra}l_a m(a)da = b, \text{ or}$$

$$(2) \qquad \int_0^\omega e^{-ra}l_a m(a)da = 1$$

Our problem is to compare two age distributions, c(a) and c′(a), given two mortality schedules, l_a and l'_a, and two fertility schedules, m(a) and m′(a). The two may be compared by taking the ratio of one age distribution to the other:

$$(3) \qquad \frac{c'}{c}(a) = \frac{b'}{b}\,\frac{l'_a}{l_a}\,\frac{e^{-r'a}}{e^{-ra}} = \frac{b'}{b}\,\frac{l'_a}{l_a}\,e^{-\Delta ra}$$

where Δr is the difference between the two growth rates.[2]

We will observe at what ages this ratio $\frac{c'}{c}$ increases, at what ages it decreases (and by how much) in response to differences in mortality and fertility.

Stable Age Distributions with the Same Mortality but Different Fertility Schedules. We first consider the ratio of two stable age distributions where $l'_a = l_a$ at all ages, but $m'(a) \neq m(a)$. Under these circumstances equation (3) takes the simple form

$$(4) \quad \frac{c'}{c}(a) = \frac{b'}{b} e^{-\Delta ra}$$

The ratio equals $\frac{b'}{b}$ at birth, and declines $100\Delta r$ per cent per year thereafter. At an age $\hat{a}$ approximately equal to the average of the mean ages in the two stable age distributions,[3] the ratio passes through unity.

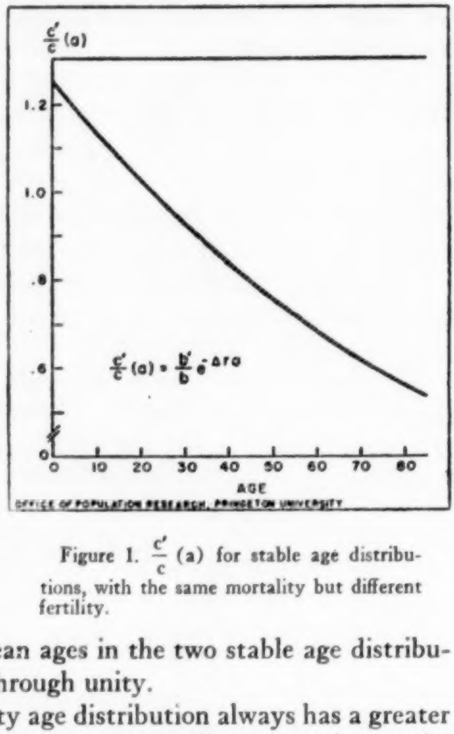


Figure 1. $\frac{c'}{c}(a)$ for stable age distributions, with the same mortality but different fertility.

Thus the higher fertility age distribution always has a greater proportion at the young ages, and a smaller proportion at the

[2] We will always designate the age distribution with the larger growth rate by a prime, so that Δr will always be positive.

[3] Lotka has shown (p. 25) that $\hat{a} = \lambda_1 - \frac{\lambda_2}{2}(r + r') + \frac{\lambda_3}{3!}(r^2 + rr' + r'^2) + \ldots$ where $\lambda_n = n^{th}$ Thielian semi-invariant of the life table. But $\frac{\bar{a} + \bar{a}'}{2} = \lambda_1 - \frac{\lambda_2}{2}(r + r') + \frac{\lambda_3}{4}(r^2 + r'^2) + \ldots$.

Thus the difference between $\hat{a}$ and $\frac{\bar{a} + \bar{a}'}{2}$ is approximately $\frac{\lambda_3}{12}(\Delta r)^2$, which is usually negligible (for the largest observed value of λ_3, and $\Delta r = .03$, this difference is about one-third of a year).

old ages, the dividing point being (loosely speaking) the mean age of the population. (*See* Figure 1.)

How much difference in fertility is required to produce a given ratio of birth rates and a given difference in r? This question is readily answered when the two fertility schedules have the same form, with one being the same multiple of the other at all ages. Thus if $m'(a) = K \cdot m(a)$,

$$\Delta r = \frac{\log_e K}{T} \text{ (approximately)}^4 \tag{5}$$

where T is the mean length of generation.

From (4) we note that $\frac{c'}{c}(\hat{a}) = \frac{b'}{b} e^{-\Delta r \hat{a}} = 1$, or

$$\frac{b'}{b} = e^{\Delta r \hat{a}} \tag{6}$$

Combining (5) and (6) we can see that

$$\log_e \frac{b'}{b} \cong \frac{\hat{a}}{T} \log_e \frac{m'(a)}{m(a)}, \text{ and} \tag{7}$$

[4] This approximate expression can be justified as follows:

(a) $e^{-rT} R_0 = e^{-r'T'} R'_0 = 1$ (where R_0 and R'_0 are net reproduction rates, and T is the mean length of generation);

(b) but $R'_0 = \int_0^\omega m'(a) l_a da = KR_0$, hence

(c) $e^{r'T' - rT} = K$

but $T = \frac{R_1}{R_0} + \frac{1}{2}\left\{\left(\frac{R_1}{R_0}\right)^2 - \frac{R_2}{R_0}\right\} r + \ldots$ (*cf.* Lotka, 1939, p. 69)

where $R_n = \int_0^\omega a^n l_a m(a) da$

Note that $R'_n = KR_n$, hence

(d) $T' \cong T + \frac{1}{2}\left\{\left(\frac{R_1}{R_0}\right)^2 - \frac{R_2}{R_0}\right\}(r' - r)$.

However, $\frac{T}{2} < -\frac{1}{2}\left\{\left(\frac{R_1}{R_0}\right)^2 - \frac{R_2}{R_0}\right\} \leq T$ empirically for a wide range of fertility and mortality schedules, hence $T(1 - \Delta r) \leq T' < T\left(1 - \frac{\Delta r}{2}\right)$.

(c) can be rewritten: $r'T' - rT = \log K$, and thus

(e) $\frac{\log K}{T\left(1 - \frac{r'}{2}\right)} < \Delta r \leq \frac{\log K}{T(1 - r')}$;

hence (5) can be off at most by a factor of $\frac{1}{1 - r'}$. However $|r'| \leq .03$ in almost every instance; (5) therefore holds to within about 3 per cent.

$$\log_e \frac{c'}{c}(a) \cong \frac{\hat{a} - a}{T} \log_e \frac{m'(a)}{m(a)} \tag{8}$$

Whether the ratio of the birth rates is greater or less than the ratio of fertilities depends on whether $\hat{a}$ is greater or less than T. This result is quite in accord with common sense, since all ages less than $\hat{a}$ have proportionately greater numbers when fertility is high. When $\hat{a}$ is greater than T, the central age of childbearing (to characterize T loosely) has relatively greater numbers in the high fertility age distribution. High fertility is thus combined with a favorable age distribution to produce a more than proportionate rise in the birth rate.

If the two fertility schedules do not differ merely in level, but also in form, equation (5) above will no longer hold. In the more general case, Δr may be expressed as follows:

$$\Delta r = \frac{\log_e \frac{R'_0}{R_0} - r\Delta T}{T'} \tag{9}$$

If the fertility schedules differed only in the age at which each level of fertility was reached, the principal determinant of Δr would be the difference in T. If $m'(a) = m(a-x)$, ΔT would be approximately equal to $-x$ and $\log \frac{R'_0}{R_0}$ would differ from 0 only because the m′ schedule of fertility, occurring at younger ages, would be combined with lower mortality rates. In this instance, (9) can be written, approximately:

$$\Delta r \cong \frac{\log_e \frac{l_{T-x}}{l_T} + rx}{T - x} \cong \frac{{}_xq_{T-x} + rx}{T - x} \tag{10}$$

where ${}_xq_{T-x}$ is the probability of dying between ages $T-x$ and T (Dublin and Lotka, 1925).

Differences in fertility, in sum, produce a very simple difference in stable age distributions: one age distribution has a higher initial ordinate and a steeper slope than the other, larger fractions of its population in the younger ages, an equal fraction at the mean age, and smaller fractions at the older ages.

Stable Age Distributions with the Same Fertility but Different Mortality Schedules. The effect of different mortality rates on the stable age distribution is more complicated than the effect of differences in fertility.

The general expression for the ratio of the two age distributions is:

$$\frac{c'}{c}(a) = \frac{b'l'_a}{bl_a} e^{-\Delta ra} \tag{3}$$

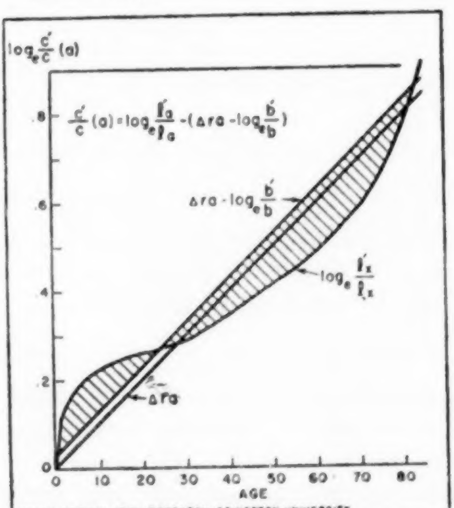
In its logarithmic form, this equation becomes

$$\log \frac{c'}{c}(a) = \log \frac{l'_a}{l_a} - \left(\Delta ra - \log \frac{b'}{b}\right) \tag{11}$$

Figure 2 represents the right-hand side of equation (11) geometrically, and isolates the factors which determine the differences in two stable age distributions.

The vertical dimension of the cross-hatched area represents $\log \frac{c'}{c}(a)$, being $\log \frac{l'_a}{l_a} - \left(\Delta ra - \log \frac{b'}{b}\right)$. Where the distance between the two lines is great, the ratio of $\frac{c'}{c}$ (a) differs substantially from unity. The two lines intersect at ages where the two distributions have the same proportions.

Figure 2. The ratio of two stable age distributions, with the same fertility but different mortality.



We will next describe the basis for the geometric constructions in Figure 2 which enable us to determine Δr and $\frac{b'}{b}$ from a knowledge (primarily) of $\log \frac{l'_a}{l_a}$.

These geometric constructions are based on two equations, and an approximation to $\log^x$ when $|x-1|$ is small.

The first of the equations underlying our construction follows directly from (2):

$$\int_{a_1}^{a_2}(e^{-r'a}l'_a - e^{-ra}l_a)m(a)da = 0 \quad (12)$$

where a_1 and a_2 are the youngest and oldest ages of childbearing.

The second equation results from the necessity for each age distribution to total 100 per cent:

$$\int_0^{\omega}(b'e^{-r'a}l'_a - be^{-ra}l_a)da = 0 \quad (13)$$

We will now consider the approximation $\log(x) \cong x-1$ (when x is near to 1) as applied to $\log\left(\frac{l'_a}{l_a}e^{-\Delta ra}\right)$.

$$\log\left(\frac{l'_a e^{-r'a}}{l_a e^{-ra}}\right) \cong (e^{-r'a}l'_a - e^{-ra}l_a)\frac{1}{e^{-ra}l_a} \quad (14)$$

When (14) is compared with (12), it becomes clear that

$$\int_{a_1}^{a_2}\log\left(\frac{l'_a}{l_a}e^{-\Delta ra}\right)e^{-ra}l_a m(a)da \cong 0, \text{ or that}$$

$$\int_{a_1}^{a_2}\left(\log\frac{l'_a}{l_a} - \Delta ra\right)c(a)m(a)da \cong 0 \quad (15)$$

Equation (15) tells us that from ages 15 to 45 the positive areas between $\log\frac{l'_a}{l_a}$ and Δra are approximately balanced by the negative areas when the areas are "weighted" by the number of births at each age of mother. This relation enables us to estimate Δr quite closely by graphical methods. One plots $\log\left(\frac{l'_a}{l_a}\right)$, draws a vertical line at 15 and one at 45, and pivots a straight line on the origin, until, making allowance for weighting, the positive and negative areas between the straight and curved lines are balanced in the interval 15 to 45.

In Figure 3 the straight line is adjusted until the two shaded areas, weighted by the curve drawn directly beneath, are equal.

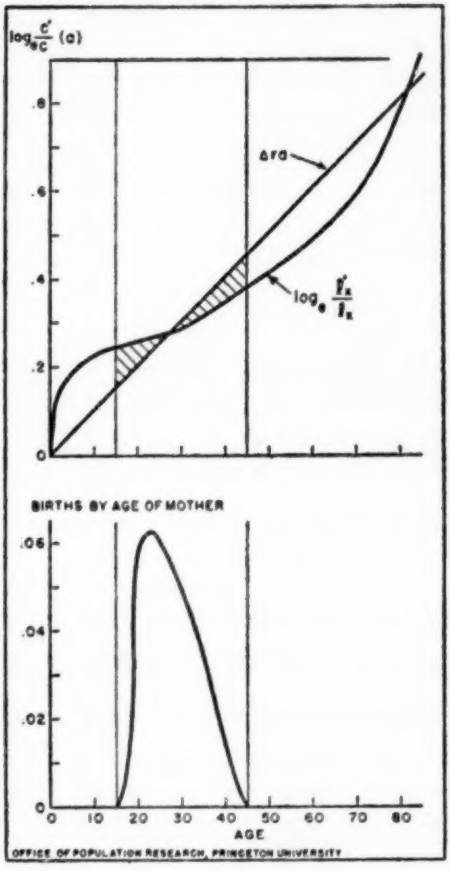


Figure 3. Determining the change in the intrinsic rate of growth, with changing mortality and constant fertility.

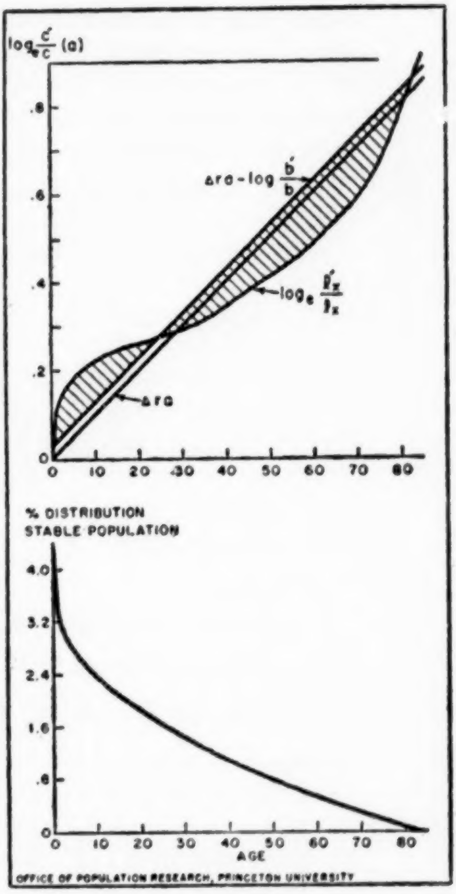


Figure 4. Determining the ratio of birth rates and the ratio of the proportions at each age in two stable age distributions, with different mortality but the same fertility.

There is a simple common sense basis for equalizing these areas. The distance between the two lines represents the log of the ratio of one age distribution to the other, when both are drawn from the same initial ordinate—when we assume $b' = b$. If the birth rates *were* equal, the excess mothers of one age distribution at some ages (weighted by their childbearing rates)

would have to be balanced by a relative deficit of mothers at other ages (weighted by *their* childbearing rates). In other words, if we equalize the births, the assumption of constant fertility requires that childbearing women should also be in some sense equalized.

There remains the determination of $\frac{b'}{b}$. By the same approximation used in (14), we may express $\log \frac{c'}{c}(a)$ as:

$$(16) \quad \log\frac{c'}{c}(a) \cong \left(\frac{c'}{c}(a) - 1\right) = (c'(a) - c(a))\frac{1}{c(a)}$$

When (16) is compared with (13), it becomes clear that

$$\int_0^{\omega}\left(\log \frac{c'}{c}(a)\right)c(a)da \cong 0, \text{ or that}$$

$$(17) \quad \int_0^{\omega}\left\{\log \frac{l'_a}{l_a} - \left(\Delta ra - \log \frac{b'}{b}\right)\right\} c(a)da \cong 0$$

$\text{Log}\,\frac{b'}{b}$ can be estimated by a graphic method similar to that employed for estimating Δr. One draws a straight line parallel to Δra such that the positive areas between the line and $\log \frac{l'_a}{l_a}$ balance the negative areas, when both areas are weighted by $c(a)$. In Figure 4, the positive shaded areas are made equal to the negative shaded areas, when the areas are weighted by the age distribution $c(a)$, sketched at the bottom of Figure 4.

The analysis of mortality differences might end here were it not for the fact that many actual mortality changes conform to a rather simple pattern, which can be expressed as the sum of three even simpler components. The total effect on the stable age distribution of a typical change from one life table to another is the same as if these three component changes had occurred sequentially.

The three components of the typical pattern found in life table changes are labeled A, B, and C in Figure 5.

Curve D represents the combination (sum) of A, B, and C. The typical pattern consists of a relatively sharp rise of $\log \frac{l'_a}{l_a}$ beginning at age zero and extending (with diminishing slope) through the early childhood years, a nearly linear rise extending from age 5 to age 50, 60, or beyond, and section of increasing steepness in the older ages. The linear portion is extended and lowered so that it passes through the origin, forming A in Figure 5. The excess improvement in $\log \frac{l'_a}{l_a}$ in childhood is represented by B, and the excess in the older ages by C. We will now show the effects of component A—a linear $\log \frac{l'_a}{l_a}$ that passes through the origin.

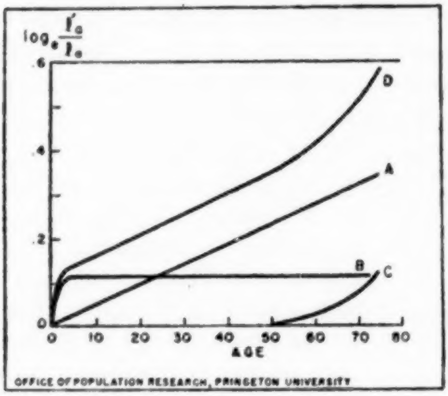


Figure 5. Components of $\log_e \frac{l'_a}{l_a}$ in a typical change in mortality.

(*i*) *Curve A in Figure 5.* The linear rise in $\log \frac{l'_a}{l_a}$ is the simplest to analyze. Assume $\log \frac{l'_a}{l_a} = sa$, where s is constant. Under these circumstances, $l'_a = l_a e^{sa}$. Also $\Delta r = s$, $\frac{b'}{b} = 1$, and the two age distributions are identical! This type of mortality difference, of course, is one where the slope of $\log \frac{l'_a}{l_a}$ is constant. Now the slope of $\log \frac{l'_a}{l_a}$—which is equal to $\frac{d}{da}(\log l'_a - \log l_a)$—equals the difference in what is called the force of mortality at age a. If the slope is constant, the change in the force of mortality is

the same for all ages. A direct implication of the constant slope is that the probability of surviving for a given period (say a year) is changed in the same proportion at all ages. If the proportionate change in the probability of surviving at every age is the same, the two stable populations will have growth rates differing by an amount equal to the uniform difference in the probability of surviving, but will have precisely the same age distributions.[5] This result can be readily understood by observing that the higher probability of surviving (which with a given growth rate would tend to make the population older) is exactly offset by the higher growth rate (which with a given life table would tend to make the population younger).

(*ii*) *Curve B in Figure 5.* The B curve in Figure 5 represents an improvement in mortality concentrated in the early childhood ages. Such a difference has an effect similar to that of different fertility. In fact, if the mortality difference were wholly in the first few moments after birth (to take the extreme case), it would be indistinguishable from a difference in fertility. The age distribution is indifferent, we might say, as to whether a greater flow of infants emerges from a higher birth rate or from a lower infant mortality rate.

Assume, then, that $\frac{l'_a}{l_a} = k$ for $a \geqq \varepsilon$, ε being a small positive

[5] This conclusion is seen immediately from the graphical technique outlined above for determining Δr and $\log \frac{b'}{b}$. It can also be shown analytically as follows:

Let $l'_a = l_a e^{sa}$

Then from (12):

$$\int_{a_1}^{a_2} (e^{-r'a} l_a e^{sa} - e^{-ra} l_a)\, m(a)\, da = 0$$

or

$$\int_{a_1}^{a_2} (e^{-(r'-s)a} - e^{-ra})\, l_a m(a)\, da = 0$$

With l_a and $m(a)$ everywhere non-negative, this last equation can hold only if $r' = r + s$, or if $\Delta r = s$.

But $c(a) = \dfrac{e^{-ra} l_a}{\int_0^\omega e^{-ra} l_a\, da}$,

and $c'(a) = \dfrac{e^{-r'a} l'_a}{\int_0^\omega e^{-r'a} l'_a\, da} = \dfrac{e^{-(r+s)a} e^{sa} l_a}{\int_0^\omega e^{-(r+s)a} e^{sa} l_a\, da} = c(a)$

number. Consider the substitution of l'_a for l_a in equation (2). We obtain

$$(18)\qquad \int_{a_1}^{a_2} e^{-r'a} l'_a m(a)\,da = k \int_{a_1}^{a_2} e^{-r'a} l_a m(a)\,da = 1$$

This is precisely the same expression one would obtain if the life tables were the same, and $m'(a) = km(a)$. Hence the difference in r is precisely the same whether one considers a different life table with k times the probability of surviving to an early age and unchanged probabilities from that age on, or considers a different fertility schedule with k times the fertility level at all ages.

Thus for this assumed difference in mortality,

$$(19)\qquad \Delta r \cong \frac{\log \frac{l'_e}{l_e}}{T}$$ (from considerations similar to those underlying (5))

and

$$(20)\qquad \log \frac{c'}{c}(a) \cong \frac{\hat{a} - a}{T} \log \frac{l'_e}{l_e}$$

(from considerations similar to those underlying (8))

However, the ratio of the intrinsic birth rates would be quite different when the difference in age distribution arises from a difference in infant mortality rather than a difference in fertility.

Since $\frac{c'}{c}(\hat{a}) = \frac{b'}{b} \cdot \frac{l'_e}{l_e} \cdot e^{-r\hat{a}} = 1$,

$$(21)\qquad \log \frac{b'}{b} = \Delta r\hat{a} - \log \frac{l'_e}{l_e}$$

When the difference in r arises wholly from a fertility difference, $\log \frac{l'_e}{l_e} = 0$, and $\log \frac{b'}{b}$ is equal to $\Delta r\hat{a}$. If $\hat{a} = T$, the ratio of the birth rates is the same as the ratio of fertilities. On the other hand, if infant mortalities differ and fertility rates are unchanged, the two stable populations will have the same birth rate when $\hat{a} = T$.

The combined effect of mortality improvements represented by curves A and B and Figure 5 are:

(1) To raise the growth rate by the sum of the slope of A, and the rise that would be caused by an increase in fertility equivalent to the extra improvement in mortality at early ages.

(2) To change the age distribution in a way nearly equivalent (for all but the very youngest ages) to a rise in fertility which would yield the same increased flow of 5-year olds.

(*iii*) *Curve C in Figure 5.* Finally, we turn to the effects of curve C in Figure 5—the extra improvement in $\log \frac{l'_a}{l_a}$ in the older ages.

The expression for $\frac{c'}{c}(a)$ for this case becomes simply:

$$\frac{c'}{c}(a) = \frac{b'}{b} \cdot \frac{l'_a}{l_a} \tag{22}$$

because $\Delta r = 0$. The intrinsic rate of increase is unaffected by changes in older age mortality since it is wholly determined by fertility rates and by mortality rates within and before the childbearing ages. Moreover, b′ differs from b only because the greater proportion of older persons affects the relation of births to the total population: the ratio of births to the population under 50 is the same in both age distributions. The ratio $\frac{b'}{b}$ may be estimated by first noting that

$$\int_0^{\omega}\left(\frac{c'(a)}{c(a)} - 1\right)c(a)da = 0 \tag{23}$$

or that

$$\int_0^{\omega}\left(\frac{b'}{b}\frac{l'_a}{l_a} - 1\right)c(a)da = 0$$

Since $\left(\frac{b'}{b}\frac{l'_a}{l_a} - 1\right) \cong \log\frac{b'}{b} + \log\frac{l'_a}{l_a}$,

$$\int_0^{\omega}\left(\log\frac{l'_a}{l_a}\right)c(a)da \cong \log\frac{b}{b'}\int_0^{\omega}c(a)da \tag{24}$$

but from 0 to a_0, $\log \frac{l'_a}{l_a} = 0$, and $\int_0^\omega c(a)da = 1$. Hence

$$\log \frac{b}{b'} \cong \int_0^\omega \log \frac{l'_a}{l_a} c(a)da. \tag{25}$$

We may make a final approximation. There exists an $\bar{a} > a_0$, such that

$$\int_{a_0}^\omega \log \frac{l'_a}{l_a} c(a)da = \log \frac{l'_{\bar{a}}}{l_a} \int_0^\omega c(a)da.$$

If $\log \frac{l'_a}{l_a}$ rose linearly, and $c(a)$ declined linearly, from a_0 to ω, $\bar{a}$ would lie one-third of the way along the interval from a_0 to ω. Thus when only a negligible fraction survive above age 90, the assumption of linearity in $\log \frac{l'_a}{l_a}$ and in $c(a)$ above a_0 leads to the approximation:

$$\log \frac{b}{b'} \cong \left(\log \frac{l'_{\bar{a}}}{l_{\bar{a}}} \right) c(a_0+) \tag{26}$$

where $\bar{a} = \frac{2}{3} a_0 + \frac{1}{3} (90)$.

In other words, the per cent difference in the birth rate is proportional to the per cent difference in l_a for a centroidal age above a_0, and to the fraction above a_0 in the original age distribution.

The rather intricate reasoning in the discussion to this point may have obscured some of the more important results that the analysis implies. We will try to illuminate the more interesting conclusions—and incidentally show how the analysis works out in numerical form—by considering an empirical example.

The example is based on Swedish vital rates at the turn of the century and near the middle of the century. Specifically, it contrasts the stable age distribution accompanying Swedish fertility of 1896–1900 (gross reproduction rate 1.95) and mortality of 1891–1900 (expectation of life 53.6 years) with the age distribution implied by the fertility of 1950 and mortality of 1946–50 (gross reproduction rate 1.11, expectation of life 71.6

years). The most notable change (Fig. 6) is the increase in proportions at the older ages. Until recently, this sort of "aging" was commonly attributed to declines in both fertility and mortality.[6] However, it is clear from Figure 7 that improved mortality acting alone would have produced a *younger* distribution. The decline in fertility was not merely the principal force responsible for the "aging" population; it actually had to overcome an opposing force caused by the change in mortality.

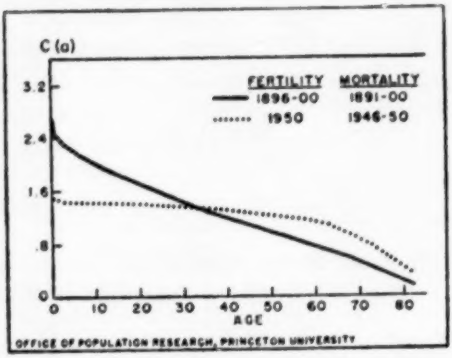


Figure 6. Stable age distributions for females in Sweden in 1896–1900 and in 1950.

These results are fully explained by our analysis. The difference between curves 1 and 3, and between curves 2 and 4 in Figure 7 is the result of the "pivoting" effect of a change in fertility —the point of pivoting being the average of the average ages. Note that the intersection of 2 and 4—which involves higher mortality—occurs at a slightly higher age, indicating that higher mortality produced a slightly greater average age.

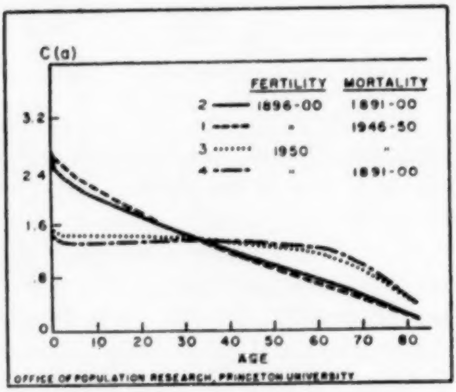


Figure 7. Stable age distributions associated with various combinations of fertility and mortality from Swedish experience around 1900 and 1950.

[6] Lorimer and Sauvy have both shown that the common belief that mortality reduction typically produces an older population is mistaken (Lorimer, 1951; Sauvy, 1954).

In accounting for the effect of mortality changes, we need to examine first the age pattern of mortality improvement. Figure 8 shows this pattern in the form of the natural logarithm of the ratio of survivors at each age in the two Swedish life tables. The pattern, it turns out, can be accurately represented by constituents A, B, and C (*cf.* Fig. 5). Thus the analysis presented in equations (18) through (26) is fully applicable.

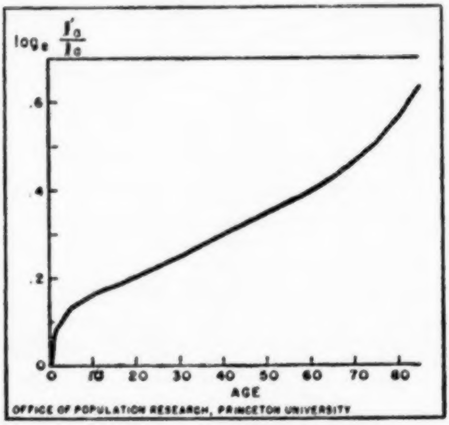


Figure 8. The natural logarithm of the ratio of the survivors to each age in the life tables for 1946–50 and 1891–1900 (Swedish females).

With the aid of this analysis, we may note the following features of our example:

(1) The decline in fertility produced a larger effect than the decline in mortality on the intrinsic rate of increase. Fertility acting alone would have reduced r by 17.7 per thousand, whereas the decline in mortality would have raised r by 8.2 per thousand.

(2) The increase in growth rate associated with the linear constituent A of changing mortality accounted for 4.7 per thousand of the change in r while the excess improvement in childhood mortality (B component) increased r by about 3.6 per thousand (Equation (19)).

Thus the decline in mortality, though it had nearly half as great an effect on growth as fertility, had a much smaller effect on the age distribution.

(3) The effect of the B component—the extra improvement in mortality in childhood—on the age distribution is equivalent to a 12 per cent rise in fertility, except for the effect on ages under 5. (*See* equation (20) and Fig. 9.) Note the effect of the extra improvement in mortality in the older ages (the C component) in causing a divergence at these ages from the age

pattern which would be caused by a 12 per cent rise in fertility.

(4) The age distribution effect of the same decline in childhood mortality is greater when fertility is held constant at a low rather than a high level. (*See* Fig. 10.) This result is understandable when one recognizes that the improvement in childhood mortality causes the age distribution to pivot approximately on the average age. With low fertility and a relatively great average age, this pivoting action raises the proportion of women at the most fertile ages, and the increased survival in early childhood is reinforced by a rise in the number of mothers. (*See* equations (20) and (21).)

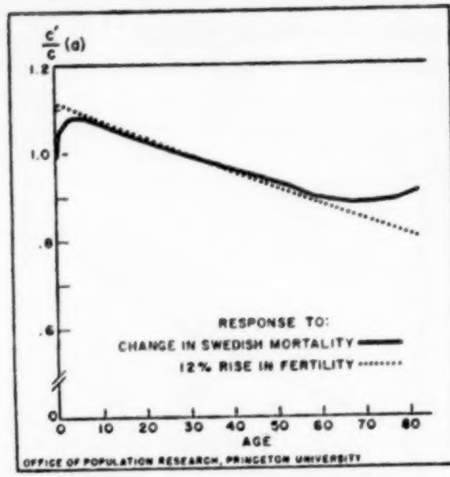


Figure 9. $\frac{c'}{c}$ (a) in response to an improvement in mortality, and in response to a nearly equivalent rise in fertility.

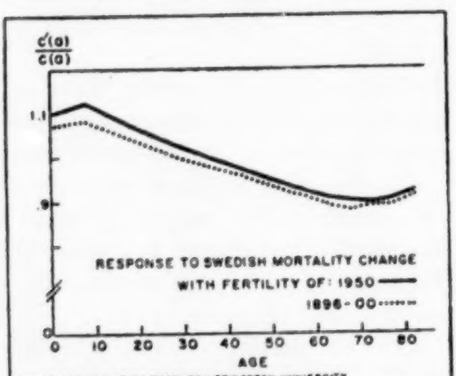


Figure 10. $\frac{c'(a)}{c(a)}$ for various combinations of Swedish vital rates.

(5) In spite of the C component (the extra mortality improvement in the older ages), the fraction at these ages is diminished, not increased, by reduced mortality. This result arises because the B component is so large, while the C component is only moderate.

Some of the results illustrated by the Swedish example are universal—such as the nature of the effect of declining fertility. However, the results of changing mortality depend (we repeat) on the age pattern of the change; and of course the results in the example can be taken as typical only of instances with a similar pattern.

To get an idea of the prevalence of this pattern of changing mortality, we have surveyed a large number of pairs of life tables,[7] each pair contrasting the experience of some area at two different dates. Some of the results of this survey are presented below. The pairs of life tables are collected in groups on the basis of time interval spanned, and on the basis of rough similarity of mortality level during the same interval.

Group I consists of pairs of life tables for 11 European areas during the last half of the nineteenth century (life tables for Belgium, Berlin, Breslau, England and Wales, France, Germany, Italy, Netherlands, Prussia, Sweden, and Switzerland). Group II consists of tables for 15 countries with a relatively high expectation of life in the interval 1900–1941 (Australia, Canada, Denmark, England and Wales, France, Germany, Iceland, Netherlands, Norway, Sweden, Union of South Africa, and the United States). Group III is made up of life table pairs for 9 countries with relatively high mortality in the twentieth century (British Guiana, Chile, Ceylon, Jamaica, Japan, Mexico, Portugal, Taiwan, and Trinidad and Tobago). Group IV consists of life tables for 9 countries with a high expectation of life and a substantial improvement in mortality during the interval covered—from the 1930's to the present.

We will first summarize the linearity of $\log \frac{l'_a}{l_a}$ from ages 5 to 50 for the life table pairs in these groups.

It is notable that 39 out of 44 life table pairs have a $\log \frac{l'_a}{l_a}$

[7] This survey was made easy by access to the life tables collected by Professor George J. Stolnitz of the Office of Population Research—a collection including substantially all of the national life tables ever published, and a large number of life tables for non-national areas as well.

Group	Deviation <.01	Deviation .01 to .02	Deviation .02 to .03	Deviation .03 to .04
I. Europe, 1850–1900	6	5	0	0
II. Low Mortality, 1900–1940	13	2	0	0
III. High Mortality, 1900–	3	1	2	3
IV. Low Mortality, 1935–	9	0	0	0

Table 1. Number of life table pairs with given maximum deviation from straight line of best fit, $\log \frac{l'_a}{l_a}$ from age 5 to age 50, by groups.

function linear within 2 per cent from 5 to 50. The maximum departure from linearity shows the maximum error one would make in estimating the altered stable age distribution on the assumption that the change *was* linear. In nearly 90 per cent of the life table pairs this error would be less than 2 per cent. (Less than 2 per cent of the size of the group itself. Thus if the group 20–24 actually constitutes 10 per cent of the population after the improvement in mortality, it would be estimated within the interval 9.8 to 10.2 per cent.)

The significance of departures from linearity can be better appreciated when we observe what linearity in $\log \frac{l'_a}{l_a}$ implies about changes in the probability of surviving. If $\log \frac{l'_a}{l_a}$ is linear over an interval, the probability of surviving changes by the same proportion at all of the ages the interval covers. Thus if $\log \frac{l'_a}{l_a}$ is linear from 5 to 50, the probability of surviving from age 5 to age 6 is increased by the same factor as the probability of surviving from 30 to 31, from 45 to 46, etc. If the probability of surviving a year is close to unity at some ages—say .99 or more—there is *room* for only a slight proportional increase. It turns out, in fact, in all three cases listed in Table 1 of a departure of more than .03 from linearity, that if the average improvement from 5 to 50 in the probability of surviving had applied at all ages, some mortality rates would have become negative. In other words, the most prominently nonlinear mor-

tality improvements *could not possibly* have been linear—the improvement was too large. Even in these cases, however, the use of a linear relationship as an approximation to the actual change produces only a slightly inexact estimate of the resulting stable age distribution.

Next we will consider the prevalence of B and C components in the mortality improvement patterns. In all forty-four life table pairs the probability of surviving to age 5 increases in greater proportion than the change in any other 5-year probability under age 50. In other words, the existence of a noticeable positive B component is universal for this selection of mortality changes. However, among group IV (most recent experience of low mortality areas) the B component is less pronounced. The C component (excess improvement in the older ages) is pronounced in all instances except 5 in group I, 4 in group II, 2 in III, and 1 in group IV. The proportional increase in the probability of surviving above age 50 typically exceeds the increase for 5 to 50 by the widest margin in group IV. In short, the C component clearly exists in thirty-two of forty-four pairs of life tables. In the recent experience of advanced countries, it is becoming more pronounced relative to the other components.

The last part of our survey will examine the effect of changes in mortality on the median age of the stable age distribution. The results are shown in Table 2.

Table 2 was prepared by applying the analysis presented in Figures 3 and 4 to $\log \frac{l'_a}{l_a}$ for all life table pairs. The reason for

Table 2. Effect of reduced mortality on the median age of the stable population.

Group	Median Age Lowered Whether Fertility Is High or Low	Median Age Lowered Only If Fertility Is High	Median Age Raised
I	10	1	0
II	15	0	0
III	8	1	0
IV	2	3	4

differentiating the first two columns can be seen from Figure 4. When log $\frac{l'_a}{l_a}$ rises steeply enough in the older ages to produce an increase in the fraction above some older age, say 67 years, this effect will *raise* the median age if the original fraction over 67 is high; otherwise the rise in the proportion aged will be swamped by the increase in very young. But whether there is or is not a large fraction over 67 in the initial stable distribution depends on whether fertility is high or low. Life table pairs assigned to column 1 of Table 2 either show a decrease at all ages above the original median or show a decrease at all ages up to a very advanced age. In these instances the median age is lowered without regard to the fertility level. In the second column, the $\frac{c'(a)}{c(a)}$ fractions associated with the life table pairs have a substantial positive area above age 60 or so, and a substantial positive area below age 20. Which of these predominates in affecting the median age depends on the fertility level. The four life table pairs in column 3 combine pronounced old age improvement with a relatively meager improvement in childhood mortality.

Our survey shows that our Swedish example is typical of a wide range of vital rate changes in the following ways:

(1) The effect of declining fertility is universally to lower the growth rate, increase the fraction at ages under the average age, and decrease the fraction at higher ages.

(2) The majority of the life table pairs examined resembled the Swedish mortality change in the approximate linearity of the A component and in having positive B and C components.

(3) The B component tends to be less pronounced and the C component more pronounced in the recent experience of low mortality areas.

(4) In all but a small fraction of instances examined, the effect of mortality improvement would be to lower the median age of the stable age distribution.

Since mortality rates up to age 50 have reached very low

levels in the areas of lowest mortality today, there is very little room for improvements having the effect of making the population younger. For example, if all deaths under age 5 were eliminated in Sweden, and no other mortality changes occurred (this is the *maximum* B component), the effect would be equivlent only to a 2.5 per cent increase in fertility. In other words, further substantial improvements in mortality in the regions which today have the highest expectations of life will have to occur in ages above 50, where the age distribution effect is in one direction only—that of producing an older population.

Transitory Changes in Age Distributions Arising from Changes in Mortality and Fertility Rates

The stable age distribution ultimately associated with a schedule of vital rates clearly contrasts the effects of different changes in fertility and mortality. However, the stable age distribution is sometimes approached only after a long interval—perhaps 60 years or more—of approximately constant rates. When fertility changes are substantial, or when sharp decreases in infant and child mortality occur, the transitory age distribution may depart markedly from the stable form. In view of the increasingly uncertain course of human affairs as one looks further into the future, these "transitory" age distributions often have more practical interest than the remote stable distribution.

The conventional method for calculating the population resulting from a particular course of vital rates is component projection. This method is flexible enough to handle any course whatever of age specific rates, and any initial age distribution. But it is not always clear in a component projection whether particular features of a projected age distribution are the result of birth rate changes, death rate changes, or of the character of the initial age distribution. The role of the various factors can be clarified, however, by considering projections of certain kinds of initial populations with certain simple changes in vital rates. Specifically, we will make the following simplifying assumptions:

(1) The initial age distribution is the stable age distribution implicit in the initial vital rates.

(2) The changes, if any, in fertility affect all age-specific rates in the same proportion.

(3) Mortality changes, if any, conform to the typical pattern of life table changes described earlier.

The number at each age in the initial population will be designated as n(a, 0); the number there would be at time t *if vital rates remained unchanged* will be designated n(a, t); while the number at time t *with changing vital rates* will be designated n′(a, t). Our analysis will obtain expressions for the ratio of the population at each age with changing vital rates to the population that would exist with no changes—expressions for $\frac{n'(a,t)}{n(a,t)}$, which we will designate f(a, t). Fertility and mortality changes will be considered separately.

The Effects of Fertility Changes. The fertility of all age groups will be assumed to change in the same proportion. Thus $\frac{m(a,t)}{m(a,0)} = g(t)$—all age-specific fertility rates have the same time pattern. Under these circumstances:

(1) $f(0,t) = \frac{B'(t)}{B(t)} = g(t)$ for $t \leqq a_1$

where B′ is the number of births with changing fertility, B is the number of births that would have occurred with initial fertility; $g(t) = \frac{m(a,t)}{m(a,0)}$ is the ratio of age-specific fertility at time t to that at time 0; and a_1 is the earliest age at which a significant rate of childbearing occurs.

For the first a_1 years, in other words, births will simply change in the same proportion as the change in fertility. When the interval following the initial change equals and then exceeds the earliest age of childbearing, the number of births begins to reflect two factors—the current fertility level and the altered number of mothers.

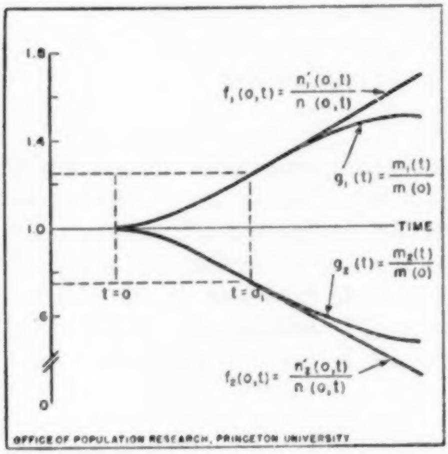


Figure 11. The effect on the number of births of increasing fertility $[g_1(t)]$ and declining fertility $[g_2(t)]$.

Figure 11 illustrates the relation between $g(t)$ (the proportionate change in fertility) and $f(0, t)$ (the proportionate change in births). When fertility is rising ($g_1(t)$), the consequent rise in births follows fertility precisely—until the number of mothers is affected. From then on the proportionate rise in births exceeds the proportion by which fertility has risen. Similar reasoning applies to declining fertility, as shown by $g_2(t)$ and $f_2(0, t)$. $f(0, t)$ may be expressed in the following functional relation:[8]

[8] Equation (2) can be derived as follows:

$$\text{(a)}\quad f(0,t) = \frac{\int_0^\omega n'(a,t)g(t)m(a)da}{\int_0^\omega n(a,t)m(a)da}$$

since the numerator gives total births from $n'(a, t)$ mothers and age-specific fertility $g(t)m(a)$, and the denominator gives total births when fertility remains constant. (a) can be rewritten as

$$\text{(b)}\quad f(0,t) = g(t)\frac{\int_0^\omega f(a,t)n(a,t)m(a)da}{\int_0^\omega n(a,t)m(a)da}$$

and if it is noted that $f(a, t) = 1$ for $a > t$, (b) becomes

$$\text{(c)}\quad f(0,t) = g(t)\left\{\frac{\int_0^t \{f(a,t)-1\}n(a,t)m(a)da}{\int_0^\omega n(a,t)m(a)da} + 1\right\}$$

Finally, if we note that $f(a, t) = f(0, t-a)$ because of constant mortality, and in turn that $f(0, t-a) = g(t-a)$ for $t-a < a_1$, and lastly that $m(a) = 0$ for $a < a_1$, (2) follows from (c).

$$(2)\quad f(0,t)=g(t)\left\{\frac{\int_{a_1}^{t}\{g(t-a)-1\}c(a,t)m(a)da}{\int_{a_1}^{a_2}c(a,t)m(a)da}+1\right\}$$

provided $t \leqq 2a_1$.

So far we have made no use of the assumption that the initial population had a stable age distribution. In fact (2) holds generally, with $c(a, t)$ designating the fraction of the population that would have been at age a at time t if fertility had remained constant. The assumption of an initial stable age distribution simply enables us to rewrite (2) replacing $c(a, t)$ by $c(a)$. Since we have assumed mortality constant, $f(a, t) = f(0, t-a)$. $f(a', t)$ may be written:

$$(3)\quad f(a',t)=g(t-a')\left\{\frac{\int_{a_1}^{t-a'}\{g(t-a'-a)-1\}c(a,t-a')m(a)da}{\int_{a_1}^{a_2}c(a,t-a')m(a)da}+1\right\}$$

Again, the assumption that the initial age distribution is stable will permit us to replace $c(a, t-a')$ by $c(a)$. This formidable-looking expression has the following meaning. At a given time t, all cohorts born since time 0 have been affected by changing fertility. If fertility has been rising monotonically, the cohorts have been progressively enlarged. But because of the assumed constant mortality, the size of a cohort relative to what its size would have been is set at birth. Thus the cohort born $t-1$ years ago (the cohort with $a = t-1$) was determined by the fertility change in the first year after the change in fertility began. If $f(0, t)$ is plotted as in Figure 12, from time 0 to time t', then $f(a, t')$ will be unity for $a \geqq t'$; for $a < t'$, $f(a, t')$ can be obtained by plotting $f(0, t)$ from right to left beginning at $a = t'$.

Equation (3) will hold precisely provided $t \leqq 2a_1$. As t exceeds $2a_1$, $f(0, t)$ will begin to be affected by second generation births. However, the number of second generation births will

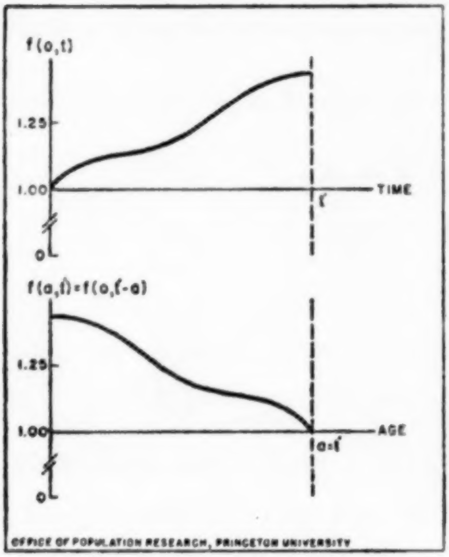


Figure 12. The relation between changing number of births [f(0, t)] and changes in the numbers at each age [f(a, t′)], with changing fertility.

be negligible for several years, and equation (3) will be a serviceable approximation for 35 or 40 years, assuming $a_1 = 15$ years.

The following steps would be necessary to make a numerical projection of f(a, t′), for $t' \leqq 35$ or 40 years, with a population initially stable, and with fertility given by $\frac{m(a,t)}{m(a,0)} = g(t)$:

(a) Calculate the population that there would have been at each age, through the relation $n(a, t') = n(a, 0)e^{rt'}$

(b) Calculate f(a, t′) for each $a < t'$ by using equation (3). Note that $f(a, t') = 1$ for $a \geqq t'$.

(c) Calculate $n'(a, t') = f(a, t') \cdot n(a, t')$.

In most instances calculation of n′(a, t′) at 5-year age intervals would be sufficient, with other ages estimated by linear interpolation.

The Effects of Mortality Changes. We will now analyze f(a, t) as age-specific mortality rates change. Here our assumptions will be:

(a) The initial age distribution is the stable distribution associated with the initial vital rates.

(b) Age-specific fertility rates remain constant.

(c) Age-specific death rates change so as to produce a pat-

tern of log $\frac{l_a(t)}{l_a(0)}$ similar to the pattern described earlier as typical. Thus log $\frac{l_a(t)}{l_a(0)}$ is the sum of three components;

(i) $\log \frac{l_a(t)}{l_a(0)} = u(t) \cdot a$ for all a

(ii) $\log \frac{l_a(t)}{l_a(0)} = v(t)$ for $a \geq 5$

(iii) $\log \frac{l_a(t)}{l_a(0)} = w(t) \cdot (a - a_0)$ for $a > a_0$; $a_0 \geqq 50$

We will not give an analytical expression to the portion of the curve between ages 0 and 5, but will only assert that log $\frac{l_1(t)}{l_1(0)}$ is typically about half of log $\frac{l_5(t)}{l_5(0)}$. Except for this interval, the three time functions, (i), (ii), and (iii), determine a relationship log $\frac{l_a(t)}{l_a(0)}$ of the form shown by the heavy line in Figure 13. The relation of $l_a(t)$ to $l_a(0)$ is specified by three parameters: the slope α of the straight line portion drawn through the origin $[\alpha = u(t)]$; the height β of log $\frac{l_5(t)}{l_5(0)}$ above $5x\alpha$ $[\beta = v(t)]$; and the extra slope γ ($\alpha + \gamma$ = total slope) of log $\frac{l_a(t)}{l_a(0)}$ when $a > a_0$. The basis for this representation of life table change is empirical; very many pairs of life tables from actual experience fit this pattern closely. (*See* discussion of life tables, p. 97.)

We will use the following procedure: (a) we will determine $f_1(a, t) = \frac{n_1(a, t)}{n(a, t)}$ where n_1 is the number at age a that there would be in response to the linear relation $\log \frac{l_a(t)}{l_a(0)} = \alpha a [\alpha = u(t)]$ acting alone; (b) we will next determine $f_2(a, t) = \frac{n_2(a, t)}{n_1(a, t)}$, where n_2 is the number resulting from a rise of mag-

nitude β [β = v(t)] above 5 · α of log $\frac{l_5(t)}{l_5(0)}$; and (c) we will finally determine $f_3(a, t) = \frac{n_3(a, t)}{n_2(a, t)}$, where n_3 is the number at age a resulting from the extra slope γ above age a_0. Then the effect of the complete change in mortality rates will be $(f_1 \cdot f_2 \cdot f_3) = f(a, t)$.

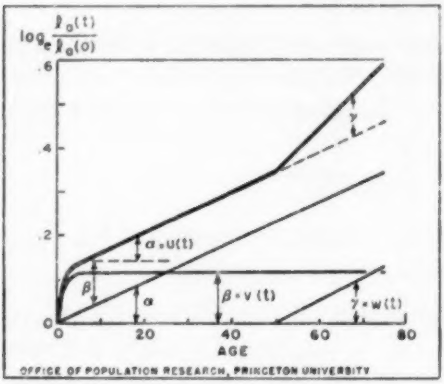


Figure 13. The components of $\log_e \frac{l_a(t)}{l_a(0)}$.

(a) The effect of α a, the linear component of mortality change.

If the only change in mortality from year 0 to year t were of the form $\log \frac{l_a(t)}{l_a(0)} = u(t)a$, the per cent age distribution in later years would be the same that would have prevailed with mortality unchanged. We will show this for year 1. The life table at the end of six months is related to the original table by an exponential factor:

$$l_a(1/2) = l_a(0)e^{u(1/2)a}$$

if according to the former mortality a certain fraction S(a) would have survived from age a to a + 1, according to the changed mortality, a fraction equal to $S(a)e^{u(1/2)}$ will survive. The fraction surviving at every age is multiplied by the same factor. Hence there would be $e^{u(1/2)}$ times as many persons at every age (including age zero, since parents are increased by the common factor, and fertility is unchanged), and thus the *proportion* at every age is left precisely as if mortality had remained constant. However, the *number* at every age is u(1/2) per cent greater than it would have been.

After t years have passed, $f_1(a, t)$ will be given by:

(4) $f_1(a, t) \cong e^{[u(1/2)+u(3/2)+\dots u(t-1/2)]}$

or more exactly,

(5) $f_1(a, t) = e^{\int_0^t u(t)dt}$

If the population at time 0 were stable with an intrinsic rate of increase r, $n(a, t)$ equal $n(a, 0)e^{rt}$ and the number resulting from the linear component of changing mortality would be

(6) $n_1(a, t) = \left(e^{rt + \int_0^t u(t)dt}\right) n(a, 0)$

(b) The effect of β $[v(t)]$—the excess at age 5 of $\log \dfrac{l_a(t)}{l_1(0)}$ over $5 \cdot a$.

The effect of a life table change of the form sketched in Figure 14 is similar to that of a rise in fertility. Consider a cohort reaching age 5 at time t ($t \leqq 15$). The cohort will be larger than it would have been, because of decreases in mortality. If the entire improvement in mortality under age 5 were concentrated in the first day of life, we could determine $f_2(5, t)$ by finding out the increase in survivorship of the first day of life that had occurred five years before t —in short, we could assert:

(7) $f_2(5, t) = e^{v(t-5)}$

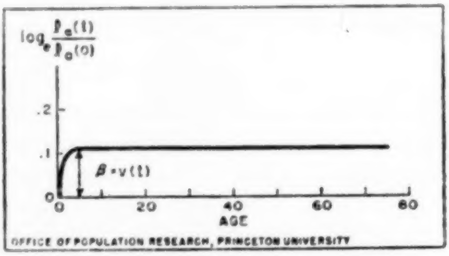


Figure 14. The excess improvement in childhood mortality $\beta = v(t)$.

On the other hand, if the entire improvement in mortality under 5 were concentrated in the last day before the fifth birthday, we could assert:

(8) $f_2(5, t) = e^{v(t)}$

But if the improvement in mortality were spread out—as it usually is—from the first to the last day of the five-year span, then we can write

(9) $f_2(5, t) \cong e^{v(t-\bar{a})}$

where $\bar{a}$ is a time lag somewhere intermediate between 0 and 5. Since, indeed, the improvement is typically more pronounced in the earlier ages of the interval, a lag of 3 or 3 1/2 years is a fair approximation to $\bar{a}$ in (9).

Once a cohort has reached age 5, changes in mortality below that age will not affect its size. The analogy between $f_2(a, t)$ and the change in numbers occasioned by a rise in fertility is now apparent. There are two factors influencing $f_2(a, t)$ for $a \geqq 5$—the first is any change in the size of the cohort at birth, and the second is the changed probability it experienced in surviving to age 5. But $f_2(0, t)$—the proportionate increase in a birth cohort—is determined by changes in the number of mothers, just as the number of mothers helped determine the birth cohort when fertility was changing. (*Cf.* equation (2) above, p. 104.)

The end result is that if we designate $e^{r(t)} = h(t)$, we obtain an expression for $f_2(a, t)$ very much like that obtained for $f(a, t)$ when fertility changes were analyzed.

$$(10)\quad f_2(a', t) = h(t - a' + 2) \left\{ \frac{\int_0^{t-a'} [h(t - a + 2) - 1]c(a)m(a)da}{\int_{a_1}^{a_2} c(a)m(a)da} + 1 \right\}$$

provided t is less than 35 or 40 years.

(c) The effect of γ $[w(t)]$, the excess slope of $\log \frac{l_a(t)}{l_a(0)}$ for $a > a_0$.

A straight line $\log \frac{l_a(t)}{l_a(0)}$ rising at an angle γ beginning at $a = a_0$ is equivalent to an increase by a factor of e^{γ} in the probability of surviving for one year at every age above a_0. As each cohort passes age a_0, it acquires an incremental growth rate $w(t)$. Thus at time t', any cohort at age $a > a_0$ will have gained in the following proportion:

$$(11)\quad f_3(a, t') = e^{\int_{t'-(a-a_0)}^{t'} w(t)dt}$$ (where the minimum lower limit of the integral is zero)

The combined effect of the three components of mortality change is: $f(a, t) = (f_1)(f_2)(f_3)(a, t)$

$$(12)\quad f(a', t') = \left(e^{\int_0^{t'} u(t)dt}\right)$$

$$h(t'-a'+2)\left\{\frac{\int_0^{t'-a'} [h(t'-a+2)-1]c(a)m(a)da}{\int_{a_1}^{a_2} c(a)m(a)da} + 1.\right\}$$

$$e^{\int_{t'-a'+a_0}^{t'} w(t)dt} \qquad \text{where } h(t) = e^{v(t)}$$

The effect of a simultaneous change in fertility, described by $\frac{m(a, t)}{m(a, 0)} = g(t)$, and in mortality, described by $\log \frac{l_a(t)}{l_a(0)} = u(t) \cdot a + v(t) + w(t)(a - a_0)$ is obtained by using the product of $g(t)$ for fertility and $h(t+2)$ for mortality in place of simply $h(t+2)$ in (12). It is interesting to note that if $\frac{1}{g(t)} = h(t+2)$, a decline in fertility would be precisely offset by the decline in childhood mortality (in excess of the average mortality decline, so to speak). Under these circumstances, the only age distribution effects of changed vital rates would be a slight decline in the fraction under 5 because of the fact that child mortality improvement is spread over the interval 0–5 rather than concentrated in the first few days of life, and possibly a rise in the fraction at older ages, due to the above-average improvements in mortality at these ages.

The transitory age distribution changes—like the changes in the stable distribution—are easier to picture with the help of an example. Our examples will by means of graphs show the effects of very sudden "step-function" changes in fertility and mortality.

Assume (as a first example) that there is a 10 per cent rise

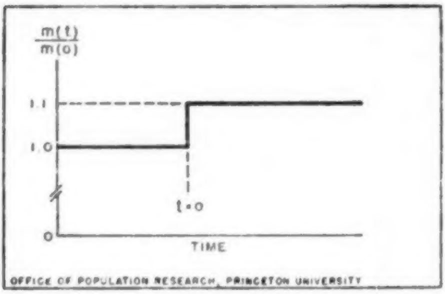


Figure 15. Ten per cent "step-function" rise in fertility.

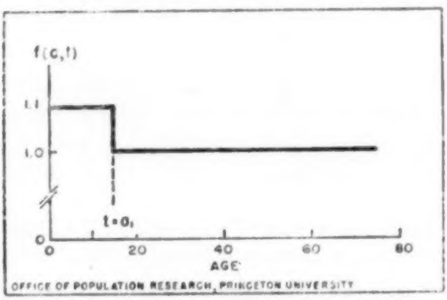


Figure 16. $f(a, t) = \frac{n'(a, t)}{n(a, t)}$, in response to a ten per cent "step-function" rise in fertility t years after the rise when $t = a_1$.

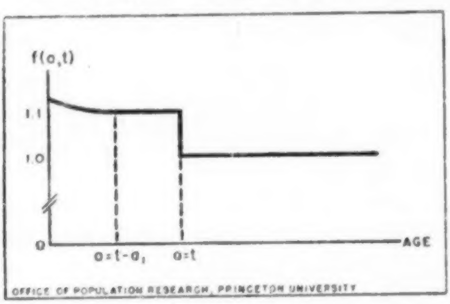


Figure 17. $f(a, t) = \frac{n'(a, t)}{n(a, t)}$, in response to a ten per cent "step-function" rise in fertility t years after the rise when $t > a_1$.

in fertility at $t = 0$, and that fertility remains at the new high levels from then on. (Fig. 15.)

Births will rise by 10 per cent, and remain 10 per cent above the formerly expected value until the number of mothers is affected. When $t = a_1$, $\frac{n'(a, t)}{n(a, t)}$ will have the appearance shown in Figure 16. But after $t > a_1$, $n'(a, t)$ for the youngest ages will begin to reflect an increased number of mothers (Fig. 17).

Later the increased daughters themselves swell the number of mothers, so that by the time t approaches ω, the number of births will have been increased by perhaps 35 per cent, as in Fig. 18.

If we consider $\frac{c'(a, t)}{c(a, t)}$ (proportionate age distributions instead of numbers at each age), the increase in the proportion

formed by the younger age groups must be offset by a decrease in the proportion in the older ages. In short, the proportionate parts of the new age distribution must still add up to one. Thus $\frac{c'(a,t)}{c(a,t)}$ cannot lie wholly above or on unity as does $\frac{n'(a,t)}{n(a,t)}$ in Figure 18. In fact, when $t = \omega$, $\frac{c'(a,t)}{c(a,t)}$ very closely resembles the relation between two stable age distributions with a 10 per cent fertility difference.

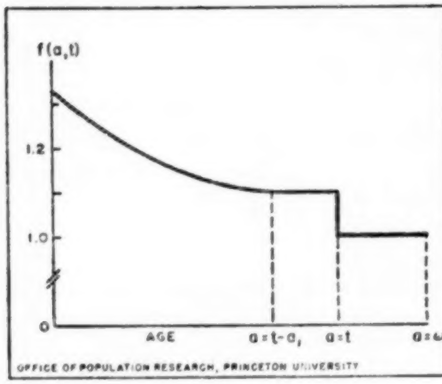


Figure 18. $f(a,t) = \frac{n'(a,t)}{n(a,t)}$, in response to a ten per cent "step-function" rise in fertility t years after the rise as t approaches ω.

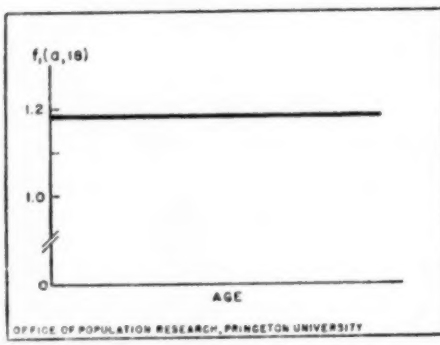


Figure 19. $f_1(a, t)$ in response to a one per cent increase in the probability of surviving at all ages 18 years after the change.

In our second example, we will consider mortality improvements which take the form of a step function of time. If u(t)—the linear component of mortality change—rises from 0 to .01 at t = 0 and remains at .01 from then on, the effect is simply to raise the growth rate by 1 per cent. In other words, $\frac{n'(a,t)}{n(a,t)} = e^{.01t}$. (Fig. 19.)

If v(t)—the excess improvement in mortality under 5—increases so as to produce a sudden 10 per cent improvement in the probability of surviving to age 5, the effect is very similar

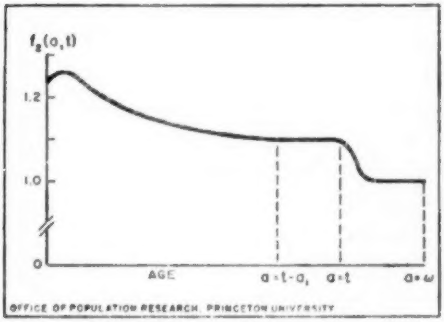


Figure 20. $f_2(a, t)$ in response to a ten per cent increase in the probability of surviving to age 5, t years after the increase.

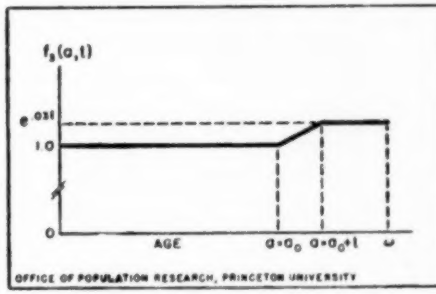


Figure 21. $f_3(a, t)$ in response to a sudden increase of three per cent in the probability of surviving at ages above a_0.

to that portrayed in Figures 16 through 18. The principal difference is that the wave-front is no longer vertical. (Fig. 20.)

Lastly, if $\omega(t)$—the excess improvement in mortality in the older ages—increases so as to produce a sudden increase in the steepness of $\log \frac{l_{(a,t)}}{l_{(a,0)}}$ for $a > a_0$, the effect is, of course, to cause a rise in the numbers above a_0. If the slope of $\log \frac{l_{(a,t)}}{l_{(a,0)}}$ is suddenly increased by .03, the effect t years later is shown in Figure 21.

The time pattern of changing rates used in these examples represents the sharpest possible sort of transient change. The examples show, in qualitative terms, that transitory effects on age distributions are in the same general direction as the eventual effects on the stable age distribution. A rise in fertility produces an increase in the proportion in the younger age groups at the expense of the older; a proportionate increase at all ages in the probability of surviving affects only the growth rate; an extra increase in survivorship at the youngest ages has an effect much like a rise in fertility; an extra increase in survivorship at the older ages tends to raise the fraction at these ages.

These conclusions are (we repeat) qualitative and inexact.

The *exact* effect on a particular age depends on too many factors to be described simply. However, one can say with every confidence of being correct that a lower course of fertility produces an older population than would a higher course, all other factors being the same; and with fair confidence that most mortality improvements in the past have produced a younger population than would have resulted from unchanged mortality, other factors the same. It seems clear, moreover, that further improvements in mortality in those areas currently having the lowest mortality risks will tend to produce an older population.

References

1. Lotka, Alfred J.: Théorie analytique des associations biologiques. Deuxième partie: Analyse démographique avec application particulière à l'espèce humaine: Paris, Hermann et Cie., 1939.

2. Lorimer, F.: Dynamics of Age Structure in a Population with Initially High Fertility and Mortality. *Population Bulletin,* December, 1951, No. 1: United Nations. Department of Social Affairs. Population Division.

3. Sauvy, A.: Le vieillissement des populations et l'allongement de la vie: *Population,* Oct.-Dec., 1954, 9: No. 4.

4. United Nations. Department of Social Affairs. Population Division: The Cause of the Ageing of Populations: Declining Mortality or Declining Fertility? *Population Bulletin,* December, 1954, No. 4.

5. Dublin, Louis I., and Alfred J. Lotka: On the True Rate of Natural Increase. *Journal of the American Statistical Association,* September, 1925, 20, No. 151.

ANNOTATIONS

INTRODUCTION TO DEMOGRAPHY[1]

Written primarily "to introduce students who are preparing for the examinations of the Society of Actuaries to the methods of demography," this volume is certain to have a wide audience among population students and research workers, in view of the pressing need for a comprehensive textbook on methods of demographic research. Lacking competence to assess its usefulness to actuaries and their students, I propose to consider the book from the standpoint of this more general interest—not, however, with the intention of criticizing its appropriately limited objective.

To begin with, Introduction to Demography will not, by itself, serve to introduce anyone to demography who lacks a knowledge of the life table, since the chapters on the life table and mortality projections presuppose some knowledge of actuarial technique. Other materials presented in advanced rather than elementary language include the mathematics of stable population theory and the logistic growth curve. The remainder of the book, however, is on a level appropriate for students with a rudimentary background in population and statistics, and an instructor could, of course, substitute readings in other works for the difficult parts. The exposition throughout is highly condensed, but lucid even where it is not elementary. There are few examples of computational procedures. Evidently these are presumed to be self-evident from the formulas or verbal outlines of techniques, but in many cases one must consult original sources—which are referred to in abundance—for the necessary

[1] Spiegelman, Mortimer: Introduction to Demography. Chicago: The Society of Actuaries, 1955. Pp. xxi + 309. $6.00.

details of procedure. The instructor using this book for a text must be prepared with a liberal supply of examples.

In scope of coverage and balance of treatment Spiegelman's book is more satisfactory than the recent texts on demographic methods by Cox, Jaffe, and Wolfenden. Each of these authors, on the other hand, develops certain topics much more fully than does Spiegelman. Referring principally to statistics of the United States, incidentally to those of Canada, the twelve chapters cover the historical background of demographic statistics, collection of census statistics and vital statistics, errors in these statistics, measures of mortality, construction of life tables from general population statistics, mortality projections, morbidity data, statistics of families (formation, composition, dissolution), measures of fertility and reproduction, population distribution (including internal and international migration), population and establishment data on the labor force, and population estimates and projections. There are numerous, up-to-date illustrative tables on population trends and characteristics in the United States, many of them drawn from post-1950 Current Population Survey reports. Interpretations of these data, however, are sketchy, where offered at all.

The book does little to clarify the proper scope of demography. Spiegelman states at the outset that "Demographic statistics deal with the quantitative aspects of the distribution, characteristics, and growth of the population of a community, whether a village, a nation, or the entire world." But later he restricts his treatment of the working population to "demographic statistics" to the neglect of "economic features," without explaining why statistics of family or personal income are less "demographic" than, say, statistics of unemployment. One would think that actuaries concerned with the money value of a man would find uses for the new census data on income. Again, one can rationalize only in terms of the special interest of the actuary the inclusion of an excellent treatment of morbidity as contrasted to the exclusion of any treatment of population composition by educational attainment, religious affiliation, and those biological and psychometric characteristics that figure in discussions of so-called population quality.

The discussion strays into socio-economic theory but rarely.

There is, however, one paragraph on optimum population, strangely placed at the end of a section on "national estimates and projections." Here Spiegelman poses as a barrier to the measurement of the optimum the circumstance that "most economic or social indicators that have been considered—such as the level of real wages and unemployment—are themselves dependent upon population size." If some such indicators were not "dependent upon population size," the idea of optimum population might well be relegated to "philosophic writings," where the author evidently feels it belongs. But the notion of an optimum has been a fruitful lead in scientific theory and research, precisely because it has stimulated students of population to investigate the ways in which social and economic indicators do vary with population size, considered either statically or dynamically.

For many problems the author describes alternative techniques and includes a statement of the major variations among them in assumption and procedure. The reader, therefore, gets an impression of the variety of tools at his disposal, but may sometimes feel a need for more guidance when faced with the necessity of determining for himself just which technique is best "adapted to the problem at hand." For example, several methods of constructing abridged life tables are listed, but with no information on their relative accuracy. By and large, an agnostic position is taken with respect to the relative merits of the many new measures of fertility and reproduction advocated in recent years.

Another illustration of the failure to sharpen issues as between alternative techniques is afforded by the treatment of standardized (Spiegelman prefers "adjusted") death rates. It is observed that "the choice of the standard population is subjective and may influence the comparison of the adjusted rates. However, this difficulty is not of great significance as long as the standard chosen is not too far removed in its population characteristics from the communities being compared." But the need for standardization arises, in part, from the very fact that at least some of the "communities being compared" are sufficiently "far removed" from the standard to make a difference in their crude rates. The treatment does nothing to dispel

the conventional misconception that the "indirect method" of standarization is merely a substitute for the intrinsically more desirable "direct method." It is noted that "the adjusted rate computed by the indirect method is dependent upon the age distribution of the community. This is not the case with the age-adjusted rate computed by the direct method." This statement, true as far as it goes, is misleading in its incompleteness. Bearing in mind that the purpose of standardization is to facilitate comparisons of two or more communities, one must recognize that, in general, the difference between the crude rates of two communities is a function of *both* the age distribution and the mortality schedule of *both* communities. (This point of view is developed in a forthcoming paper, "Components of a Difference Between Two Rates," by Evelyn M. Kitagawa.)

The discussion of standardization will gain in sophistication only when it has been identified as an *index number* problem. It has seldom, if ever, been noted in the population literature that there is a formal identity between standardization in demography and the construction of price indexes in economics. The identity is apparent if one considers not the standardized rates, discussed by Spiegelman, but the mortality indexes corresponding thereto: in Cox's terminology, the Comparative Mortality Figure (the direct-standardized rate divided by the crude death rate in the standard population) and the Standard Mortality Ratio (the ratio of actual to expected deaths, which is multiplied by the crude death rate in the standard population to obtain the indirect-standardized death rate). The CMF and SMR have the same algebraic formulas, respectively, as the well-known Laspeyres and Paasche price indexes, and the intrinsic ambiguities in comparisons of standardized rates or mortality indexes exactly parallel those involved in comparisons of aggregative price indexes (e.g. cost-of-living indexes for North vs. South). The economist's discussion of these ambiguities has been much more penetrating than the demographer's. Certainly the latter should not be content merely to recapitulate the historical confusion of the former.

Needless to say, there would be no point to the pointed remarks in this review if the target were not a work of overall excellence. The reader does not need to be reassured as to the

author's high competence, but he can be assured that the author has taken great pains to produce a text that will be invaluable to student and professional demographer alike.

OTIS DUDLEY DUNCAN

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ADAPTIVE HUMAN FERTILITY[1]

THE author of this book is a biologist with a broad interest in problems of population. His background includes a period of research with the Marine Biological Laboratory at Woods Hole, Massachusetts, work with the International Division of Health of the United States Public Health Service, and director of research for the Planned Parenthood Federation of America. He is currently executive director of the National Committee on Maternal Health. Within each of these jobs the author has maintained an interest in human population and in ways and means of developing rational means of population control.

Dr. Henshaw's book ADAPTIVE HUMAN FERTILITY begins with a description of the biological aspects of procreation. One has the feeling that the author is most completely "at home" in this area. By means of interesting charts and diagrams, he graphically describes the types of reproduction at various levels of life.

The first section of the book also contains two chapters on "inducements for fertility management." Here, the author seems to join the ranks of the pessimists in the "great debate" regarding future population in relation to resources.

In the second section of the book the author describes the various efforts at population control in primitive and more recent societies. He offers some opinions regarding future efforts at fertility control. The primitive practices include infanticide; feticide; castration; continence, chastity and celibacy; coitus interruptus, obstructus and reservatus; plant materials;

[1] Henshaw, Paul S.: ADAPTIVE HUMAN FERTILITY. New York, McGraw-Hill Book Co., 1955, 322 pp. $5.50.

subincision; infibulation; and genocide. The "more recent practices" include minor surgery (for sterilization and abortions) and contraception.

With respect to "prospective trends" Henshaw devotes much attention to the possibility of controlling conception through "natural" rather than "artificial" means. "Knowledge of the mechanisms governing sexual and reproductive behavior reveals unusual opportunities. It offers not only the prospect of controlling fertility but also means of overcoming sterility and preventing disorders of the reproductive organs (prostatic complications, menstrual discomfort, spontaneous abortion, developmental abnormalities, and others)." (P. 192.) The author emphasizes that "a well-ordered sequence of events is necessary if reproduction is to be successful." (P. 197.) "We have noted the critical levels of specific agents in the body and how the presence or absence of elements in the diet, the overfunction or underfunction of certain glands, and the occurrence or nonoccurrence of nervous stimuli may cause changes in the chain of events required for reproduction. We have noted the importance of timing in this pattern of events. When we know the balances of hormonal, enzymic, and other factors, and the multiplicity of precise conditions which must be met at numerous locations, it appears little short of miraculous that reproduction should ever be successful." (P. 205.)

With the above type of stage setting the author leads up to his "plan of population management" which he calls "teleogenesis." He explains that "the plan of teleogenesis proposes that organic growth be replaced by teleogenic growth. In other words, it proposes that the human population growth process, heretofore regulated and maintained by sexual compulsion, be regulated instead by the human will and directed toward the maintenance of optimal or teleogenic populations." The author expresses confidence that the plan is workable. The only basic requirements are that completely acceptable and effective means of contraception be developed and that "there is a general desire on the part of the people everywhere to keep family size in balance with means of support." (P. 252.) The author thinks these requirements are "reasonable, all things considered." The reviewer thinks the plan highly utopian and unrealistic.

The author, of course, does not claim that his plan of "teleogenesis" is original. Over half a century ago, Lester F. Ward advanced the theory of social telesis by which he meant the direction of human intelligence and science toward the goal of social progress. In a recent statement regarding the present status of sociology, Frank H. Hankins ventured the opinion that "social telesis has been indefinitely postponed."[2] Like eugenics, the concept of teleogenic growth may be a worthy ideal; as a pattern for action in the near future, its prospects would seem to be poor.

CLYDE V. KISER

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THE ESTIMATION OF POPULATION CHANGES FOR NEW YORK CITY[1]

THE major functions of any city government are to provide services such as police and fire protection, sanitation, and maintenance of streets. Some, including New York City, provide additional services such as public schools and higher education, hospital care to the needy and general social welfare. These functions are multiplied by the size and growth of the population (population of New York City increased 6 per cent between 1940 and 1950), and the changing ethnic characteristics of the population. Being the largest city, New York has the largest capital budget of any city in this country; its budget is larger than that of many states. Because of the size of this budget it is imperative that a more thorough knowledge of the city population be available to the local government to yield the greatest social benefit.

"The Estimation of Population Changes for New York City" was prepared by The Committee on Statistical Program for

[2] Presidential Advice to Younger Sociologists. *American Sociological Review*, xviii, No. 6, December, 1953, p. 600.

[1] The Estimation of Population Changes for New York City. Recommendations to the Mayor by the Committee on Statistical Program for the City of New York, with supporting report by Howard G. Brunsman. Russell Sage Foundation, New York, New York, 68 pp. $1.00.

the City of New York which was established in April, 1954, by the Russell Sage Foundation. In its recommendations to the Mayor, the Committee emphasizes the need for additional population data as well as refinements and changes in current available data. It emphasizes the need for current population estimates and projections by borough.

The available population data consist of: decennial census from the federal Census of Population, annual population estimates prepared by the Consolidated Edison Company, annual population estimates prepared by the Bureau of Records and Statistics of the Department of Health, annual estimates of Puerto Rican population prepared by Bureau of Applied Social Research of Columbia University, data on 1950–1953 changes in ethnic composition of population prepared by Department of City Planning, population projections for 1954, 1960, 1965, and 1970 and 1975 prepared by the Regional Planning Association, projections of public school enrollments into the late 1950's and total population for 1960 and 1970 (8,257,000 and 8,152,-000, respectively) prepared by Mayor's Committee on Management Survey, estimates of public school enrollment for the following year prepared by the Bureau of Administrative and Budgetary Research of the Board of Education, and projections of 1954 public elementary schools enrollments and 1955 estimates for junior high schools prepared by the Housing Division of the Board of Education in 1947.

Estimates of total population are recommended for thirty health center districts, sixty-nine statistical districts, and ninety-five subareas established by the city departments. The computed median population (for 1950) of the health center districts is about 267,000 and about 99,900 for the statistical districts. The 1950 population of the ninety-five subareas ranges from under 10,000 to 240,000. The 135 school study clusters' boundaries are flexible in contrast to the other units which change when the boundary of the area served by the school changes. Unfortunately, each of these subdivisions is not entirely contained in the larger division so that a basic compilation of school study clusters would not necessarily cover one entire subarea and might overlap into another subarea. This is also true of the relationship of the subarea to the statis-

tical district and the statistical district to the health center district. The estimates should be made as of July 1st in order to facilitate comparison, with the exception of school enrollment figures which are not available until October 31. Monthly estimates should be made for each borough as well as for the entire City.

There are twenty-one sources of data for preparing population estimates, of which fifteen are currently available. Most of these data would need some slight revision for presentation. The Bureau of Records and Statistics, Department of Health, New York City, has annual figures of deaths by cause, color, and age. It also provides figures on deaths by sex, age, nativity, and race, but *not* by cause. A cross-tabulation of the two tables (i.e., cause of death by age, sex, nativity, and race) is recommended in the report. The major recommended changes of existing forms of presentation are of a similar nature—more detailed reports.

Sources of data which are potentially available, are Rapid Transit Turnstile Counts, Fares Collected on Bus and Street Car Routes, Old-age and Survivors Insurance-Covered Workers and Survivors Insurance Pension Recipients, Water Accounts and Real Estate Board Occupancy Surveys. Although Mr. Brunsman does say that "the only way to obtain accurate figures on the current population of New York City" . . . "is to take a complete census or at least a very large sample census," at a cost of approximately $1,250,000, he feels that the various estimates plus "the judgment of the analyst" will suffice. He does recommend the establishment of a specialized population unit.

Adrienne P. Haine

BOOKS

In Collaboration with the Milbank Memorial Fund

Approaches to Problems of High Fertility in Agrarian Societies. [illegible] Annual Conference of the Milbank Memorial Fund, 1952. 176 pages. $[illegible].

Backgrounds of Social Medicine. [illegible] Annual Conference of the Milbank Memorial Fund, 1949. [illegible] pages. $[illegible].

Biology of Mental Health and Disease. [illegible] Round Table on Biological Aspects of Mental Health and Disease [illegible] of the Milbank Memorial Fund. New York, Paul B. Hoeber, [illegible] illustrations. $10.00.

Current Research in Human Fertility. [illegible] Annual Conference of the Milbank Memorial Fund, 1955. [illegible] pages. $[illegible].

Epidemiology of Mental Disorder. [illegible] Annual Conference of the Milbank Memorial Fund, 1950. [illegible] pages. $0.50.

The Family as a Unit of Health. [illegible] Annual Conference of the Milbank Memorial Fund, [illegible] pages. $0.50.

Family Health Maintenance Demonstration, The. A [illegible] long-term investigation of family health. Proceedings of a [illegible] at the 1953 Annual Conference of the Milbank Memorial Fund, [illegible] $[illegible].

Interrelations between the Social Environment and Psychiatric Disorders. 1952 Annual Conference of the Milbank Memorial Fund, [illegible] pages. $1.50.

Interrelations of Demographic, Economic and Social Problems in Selected Underdeveloped Areas, the. Proceedings of a Round Table at the [illegible] Annual Conference of the Milbank Memorial Fund, 1954. [illegible] pages. $1.00.

Modernization Programs in Relation to Human Resources and Population Problems. 1949 Annual Conference of Milbank Memorial Fund, 1950. 154 pages. $0.50.

Needed Population Research. By P. K. Whelpton. Lancaster, Pennsylvania. The Science Press Printing Company. [illegible] pages. $[illegible].

Nutrition in Relation to Health and Disease. [illegible] Annual Conference of the Milbank Memorial Fund, 1950. [illegible] pages. $1.00.

Problems in the Collection and Comparability of International Statistics. 1948 Annual Conference of the Milbank Memorial Fund, [illegible] pages. $[illegible].

The Promotion of Maternal and Newborn Health. [illegible] Annual Conference of the Milbank Memorial Fund, [illegible]. 229 pages. $[illegible].

Research in Public Health. 1951 Annual Conference of the Milbank Memorial Fund. 1952. 284 pages. $[illegible].

Social and Psychological Factors Affecting Fertility. [illegible] III, and IV. New York Milbank Memorial Fund, 1950, [illegible]